TROPICAL AGRICULTURE

THE OFFICIAL JOURNAL OF THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. XI, No. 3. MARCH, 1934. PRICE 6d.

CONTENTS.

	PAGE.
College Publications	49
St. Vincent Arrowroot Association	50
The Genetical Conception of the Species	51
A Fungus Parasite of Calabash	53
Miscellaneous Notes	54
Thread Blights in Trinidad	55
Notes on some other Fungous Diseases in Trinidad	67
Citrus Note	68
Agricultural Wealth from Waste	69
Cacao in Fernando Po	73
Sugar Notes	74
Chemical Notes	75
Trend of the Markets	76

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

Cables :: "Stomata." | Phone :: 2183.

TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C. 3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

COLLEGE PUBLICATIONS.

TEN years have elapsed since the publication of the first number of *Tropical Agriculture*. Admittedly this does not represent a very long period in the life of a Journal, but it is felt, nevertheless, that the time has come to cast an eye back on the road traversed and to look to the future. Although *Tropical Agriculture* was first published in 1924 we believe we are justified in claiming that it has followed much older traditions for it appeared very shortly after the publication of the *West Indian Bulletin* and the *Agricultural News* had ceased in 1922. Both these Journals, which were issued by the Imperial Department of Agriculture, had their intrinsic value as a means of disseminating agricultural and scientific information, and calling attention to the activities of the Department, while, in their own spheres of usefulness and influence they had few equals. When, therefore, the functions of the Department were amalgamated with those of the College it was felt that the complete cessation of these publications, after regular issue for 20 years, would be regrettable. It was decided in consequence to issue a new Journal which would incorporate some of the features of its predecessors, with the result that in January, 1924, *Tropical Agriculture* was launched on its career.

It should be appropriate here to refer to a valedictory message published in the last editorial of the *Agricultural News* in which the hope was expressed that the new Journal should not differ materially from, and should have similar functions as the *Agricultural News*. It was suggested, moreover, that the new Journal should "lie between the scientific bulletin containing specialised research and the local pamphlets of practical agronomic instruction". On looking back it will be seen that the policy thus outlined was, with certain modifications, not only adopted but has also been consistently followed. More recently there has perhaps been a tendency to include in our columns a greater number of technical articles. The reasons for doing this were given in 1924 when it was stated that "there was a good deal to be said for the initial publication of original research in Journals such as this, which circulate amongst general workers as well as amongst specialists". It is possible that we may since have exceeded the bounds of licence in this particular respect but this has been due

to the fact that additional expense must necessarily be involved whenever papers are published in the form of separate monographs or memoirs.

Since its inception *Tropical Agriculture* has aimed at being as comprehensive as possible in its outlook. Besides recording the activities of the College it includes technical as well as popular articles on a wide range of subjects; it contains reviews of scientific works on tropical agriculture and accounts of some of the more recent discoveries in the same field; it provides in its *Chemical* and *Sugar Notes* summaries of the more important papers published in the sphere of agricultural science and sugar technology; it supplies in its *Market Notes* up-to-date information regarding the trend of price movements of tropical crops on the world markets; it has open columns for the discussion of current topics; it furnishes quarterly, in the form of *West Indian Notes*, information relating to the progress of West Indian agriculture; lastly, it forms, by means of its *College News*, some bond of union between past students. In short, it is rendering useful services to the cause of tropical agriculture, both in the West Indies and in the Colonial Empire.

The multiplicity of the subjects dealt with may be gauged by the inclusion of articles on general agricultural policy, agricultural education, crop and animal husbandry, plant breeding, genetics, the use of fertilisers, the manufacture of crop products, agricultural economics, cost accountancy, tropical land tenure, field experiments, statistical methods, storage problems and forestry. The need for the publication of information relating to the pests and diseases of crops has been fully realised. Numerous articles have been published on a very large range of tropical crops, but particularly on bananas, cacao, sugar-cane, tropical fruits and vegetables. Briefly, in ten years a remarkable collection of authoritative contributions on tropical agriculture has been accumulated.

Mention must also be made of the series of separate publications on various subjects which have been issued in conjunction with this Journal. In this connection no fewer than nine memoirs, seven supplements, six monographs, and five reports have already appeared.

Since the first issue *Tropical Agriculture* has maintained its original form and character but some noticeable improvements in its general presentation have been introduced, largely through the efforts of its publishers, the Trinidad Government Printing Office. Its size has also increased while a comparatively new feature has been the reproduction of photographs.

The standard of *Tropical Agriculture* could not have been maintained but for the continued and willing support which it has received from members of the College staff and from many other outside contributors. As long as this Journal is honoured with this co-operation its functions are bound to extend and its influence is bound to increase. Perhaps it is not generally realised that its pages are always open to receive authoritative contributions on matters relating to tropical agriculture. It would welcome, in particular, more information on the activities of colonial agricultural departments, research stations and kindred institutions and it is suggested that past students might perhaps care to secure this information and, in this manner, contribute to the Journal more than they have done hitherto. With the assurance of additional support of this kind and the encouragement that the past has already given us, we should be able to look with greater confidence to our future.

ST. VINCENT ARROWROOT ASSOCIATION.

THIS Association recently completed the second year of its existence. Formed for the purpose of marketing the arrowroot crop of the island, it promises to be one of the most successful co-operative efforts in these islands. The growers have agreed to ship their whole crop through it and an Ordinance now exists which makes it illegal for any person to ship arrowroot otherwise. The Association is managed by a Board chosen by the members and on which the Government has three representatives. It has been assisted financially by an Imperial Government loan of £30,000 and a free grant of £3,000 to further the objects in view. Warehouses have been erected in St. Vincent for receiving the arrowroot from the members and for storing it pending shipment. The work of grading the starch into five grades is undertaken by the manager and when pulverised arrowroot is required, a suitable plant is available for sifting and grinding to the required standard. After grading the identity of the flour is lost and the whole is shipped as St. Vincent arrowroot of certain grades. The growers on delivery are advanced a certain fixed proportion of the value of the starch, small growers receiving 50 per cent. more than the larger ones. When the sale of each grade has been completed a second payment is made, based on the proceeds of the actual sales. The price at which arrowroot may be sold at destination is fixed by the Board beforehand and can only be altered with its consent.

In addition to its function as a marketing organisation, the Association is also endeavouring to improve the standard of the product. Whilst much could be done in this direction at the receiving centre, especially if it were possible to convert the whole crop into pulverised arrowroot, every effort is also being made to induce members to take the greatest possible care in the preparation of the product on the farm.

College Photograph.

Copies of the original photograph (*price* 3*s.*) of the aerial view of the College which appeared in our last issue may be obtained from W. C. Ross & Co., Frederick Street, Port-of-Spain, Trinidad, B.W.I.

THE GENETICAL CONCEPTION OF THE SPECIES*.

BY

S. C. HARLAND.

(*Communicated by N. Vavilov, Member of the Academy, the* 3. *XI.* 1933.)

AT the time of the rediscovery of Mendel's law it was thought by many students of heredity that the key to the method by which species had evolved was now available, and that Mendelian studies would throw great light on this question. This optimism soon gave way to pessimism, and in 1914 Bateson was led to enunciate his famous *reductio ad absurdum*—the "unpacking theory" of evolution, by which all characters were supposed to have originated by loss of Mendelian dominant factors. This theory was never taken seriously, even by Bateson himself, and it was regretfully admitted that genetics offered no solution of the evolutionary process. At the same time, the Darwinian theory of evolution by natural selection was quite openly abandoned by many if not most geneticists, since the hereditary variations upon which Mendelian studies were conducted possessed usually the relationship of dominant and recessive, the latter being often weak and relatively unviable, and admittedly not the kind of variation which natural selection could make use of in evolution.

With the development of modern genetics by the Drosophila school, there was a virtual shelving of the evolution question and only a faint voice was heard here and there to express belief that mutations were in some way concerned in evolution (*vide* Morgan, Baur et al).

It is only quite recently that the question of the relationship of genetics to evolution has again begun to occupy the minds of geneticists, the principal stimulating influences being the writings of Fisher, Haldane and Wright. The Darwinian theory of evolution by natural selection is now capable of reconciliation with modern genetical studies, and is again in the predominating position which it occupied before the rediscovery of Mendel's law.

It is increasingly recognised that the study of species hybrids from a genetical standpoint could throw great light on the evolutionary process. But at the same time there has been little experimental work of a conclusive or even enlightening nature since the inter-sterility of Drosophila species prevented the application of the magnificent experimental technique of that school of workers to the question of species hybrids. It is quite clear that a study of species hybrids could give some clue on the process of evolution.

Suitable experimental material for the genetic study of species hybrids is not very common, but in the genus *Gossypium*, to which the important commercial cottons belong, we find a number of species eminently adapted for the purpose. It is with some experimental data from genetic studies in this genus and some deductions therefrom that I propose to deal here.

The genus *Gossypium* possesses representatives in all continents. It includes a 13 chromosome and a 26 chromosome group of species with both wild and cultivated forms showing great diversity. Two of the 26 chromosome New World species offer quite extraordinary possibilities for the elucidation of the genetic differences in species. These are *G. hirsutum* L. (Upland cotton), the centre of origin of which, following Vavilov, is in Southern Mexico, and *G. barbadense* L. (Egyptian cotton), which originated in the Andean region of South America—probably in Peru or Ecuador. These two species are so different morphologically that no single character is identical, though they cross quite readily with few or no cytological complications. Though the species are morphologically far apart, the conjugation of the chromosomes is apparently quite normal. Now these two species have undoubtedly been separated from each other for a long period of time, probably for some millions of years. The question we have to ask is—what happens to the genes, when two species, presumably having a common origin, are isolated in two different climatic areas for such an enormous period of time?

A point of importance is that both *hirsutum* and *barbadense* possess a series of homologous characters. In both species are such pairs of characters as red and green leaf, yellow and cream corolla, presence and absence of petal spot, &c. This homology applies to practically all characters, so that in our experimental work we adopted the following procedure. A pair of homologous characters—presence and absence of the large, characteristic spot at the base of the petal, was studied first within the confines of the two individual species, and then in inter-specific crosses. The *barbadense* spot proved to be a member of a rather complex multiple allelomorph series of types with progressively smaller spots, and the character red-leaf also proved to belong to the same series. The members of the series can be described as follows: large (full) spot, intermediate spot, weak spot, no spot, and red-leaf spotless. The cross of large spot by no spot gave the usual 3 : 1 ratio of spotted to spotless in F_2.

In *hirsutum* only the types large spot and spotless are present. The cross large spot by spotless in this species also gave a simple 3 : 1 ratio in the second generation.

In *barbadense* (spotted) by *hirsutum* (spotless) such simple results were not obtained, but instead the F_2 exhibited the phenomenon known as 'blending inheritance', and a series of such minute gradations in the size and intensity of the spot appeared, that classification of the plants was quite impossible. Nor did the F_3 generation

* Reprinted from *Mem. Acad. Sci.* U.R.S.S. 1933, No. 4.

yield better results. Sometimes the 3 : 1 ratio would apparently occur, but cases of apparent dominance of spotless over spotted were also seen. It was concluded that the *barbadense* spot must be regarded as a compound character consisting of a main or basal gene—together with a series of plus modifiers intensifying the expression of the spot character. *Hirsutum* could be regarded as not possessing either the basal gene or the plus modifiers, hence the minute gradations in the spot of the interspecific F_2. Transference of the *barbadense* spot by repeated backcrossings to a *hirsutum* background finally gave a new type very weakly spotted, and this could be regarded as the manifestation of the *barbadense* full spot gene, denuded or stripped of its plus modifiers by being placed upon a *hirsutum* genotypic background. Subsequent work showed that *hirsutum* spot was a member of the *barbadense* spot multiple allelomorphic series. It is thus established that the two types of petal spot in *hirsutum* and *barbadense* are not genetically constructed in the same manner. The basal genes are not identical but allelomorphic and the *hirsutum* gene is able to produce its full effect on a background (*hirsutum*) which reduces the *barbadense* spot almost to vanishing point.

We thus have a partial answer to the question of what genetic differences exist in a homologous character in two different species of the same genus. The answer is that the character in both species may consist of a basal gene with plus modifiers, the basal genes being not identical but merely allelomorphic and each accompanied by its own peculiar system of modifiers.

The discovery that homologous characters became built up in a different genetical manner in the two species led to the following question.

Do these two species contain any genes in common or are the genes of one species all allelomorphic to the genes of the other species? A partial answer to this question is available, and it has been concluded that of ten dominant genes investigated, only one is probably identical in the two species.

All experiments show also that characters which are inherited in simple Mendelian fashion within the species, exhibit great complexity in the interspecies cross, indicating that not only do the genes capable of genetic analysis differ in the two species, but that each gene is accompanied by a modifier complex which is specific to the gene in question.

We may thus suggest that the first step in the evolution of a species is the production of new multiple allelomorphs (*vide* Haldane) which differ from the old in their capability of being influenced or affected by new modifier complexes, thus rendering possible the building up of new characters through natural selection of plus modifiers operating in the given direction.

Much further light has been thrown on the genetic differences which exist between *hirsutum* and *barbadense* by the study of the genetic behaviour of the mutant known as 'Crinkled'. Crinkled occurs relatively frequently as a mutant in *barbadense* and in that species exhibits the simple Mendelian behaviour of 3 Normal : 1 Crinkled in F_2. The mutant does not occur in *hirsutum*, so that we have an additional clear proof that the mutability of a locus is conditioned by the genotype as a whole.

Crosses of *barbadense* Crinkled with *hirsutum* normal give F_1 intermediate, and the usual blending inheritance in F_2. A complete range of types occurs in F_2 ranging from normal to a type of Crinkled more extreme even than the original mutant. It is again clear that the allelomorphic relationship between normal and Crinkled is complicated by a series of modifying genes from *hirsutum*. By means of seven back-crosses, the Crinkled mutant was transferred to a pure *hirsutum* background, and the inheritance became quite simple again. The F_1 of *hirsutum* normal by *hirsutum* Crinkled—was normal or nearly so, and the ratio of 3 Normal : 1 Crinkled was obtained in F_2.

Fisher has put forward a theory of dominance which has attracted much attention. Briefly he states that since the substitution of a gene for its allelomorph is the only genetic mechanism we are acquainted with which can be of evolutionary significance, and since the 'Wild type' is dominant to practically all mutants, there must be some process going on in nature, whereby the 'Wild type' becomes dominant to mutants. He believes that the first appearance of a mutant in the species will be as a heterozygote intermediate and inferior in viability to the 'Wild type'. In the course of a long period of time, modifying genes will affect the intermediate mutant, improve its viability, and at the same time gradually convert it phenotypically into the 'Wild type', when complete dominance results.

This theory has been accepted in the main by some geneticists and criticized by others. Sewall Wright states that it is an extraordinary thing if modifying genes for dominance not of selective value on their own account, could be selected merely because they improve a heterozygotic mutation which may not occur in the species more than once in a million times.

The experiments which we have carried out seem to me completely to disprove the Fisher theory. In *hirsutum*—a species in which Crinkled does not occur at all—complete dominance of normal nevertheless exists in some strains. Dominance cannot therefore have been attained in the manner suggested by Fisher, but is due to a modifier complex of genes which are of selective value on their own account. That is, a genetic complex which is the product of natural selection and confers the ability to survive in nature, is also a dominance complex.

Dominance modifiers are thus genes which improve the general power to live of the species.

In crosses between *hirsutum*—Crinkled and *barbadense* normal, the usual type of blending occurs in F_2. It is thus demonstrated that dominance of normal to Crinkled in these two

species is attained in two quite different ways, and that in a cross between them there occurs mutual disintegration of the two dominance modifier systems. Complete dominance can be produced in the presence of either one or the other modifier system, and it can be shown that in extracted homozygous types which contain a mixture of *barbadense* and *hirsutum* genes, and which are segregating only for the Crinkled locus—the heterozygote tends to be intermediate with dominance thus incomplete.

Some general considerations may now be discussed.

We have seen in the two species *G. barbadense* and *G. hirsutum*, that long separation over geological time has produced profound genetic changes. Many genes have evolved into new multiple allelomorphs, homologous characters have become genetically quite differently constructed, and the whole dominance complex has become different in the two species.

We may put forward our conception of the genetic constitution of the species in the brief statement that *the modifiers really constitute the species*—and that as a consequence of geographical isolation and natural selection evolution takes place by the evolution of new genes, by the production of new co-ordinated modifier systems, and by the elaboration of new dominance mechanisms.

Genetic studies of other species in the genus indicate that the degree of relationship of species within the genus can be studied in terms of modifier complexes. Thus, if a new species exhibits very complicated segregation with *barbadense* Crinkled and much less complicated segregation with *hirsutum* Crinkled we can say that the species is taxonomically closer to *hirsutum* than to *barbadense*. By placing selected mutants on different species backgrounds we are provided with genetic material by which the exact taxonomic position of a species in relation to other species in the genus can be determined. Taxonomy thus becomes merged in genetics and cytology and the determination of specific relationship ceases to be merely a matter of opinion about herbarium specimens.

The emergence of some kind of provisional explanation of the Vavilov law of homologous variation is of extensive interest, but an even wider synthesis may result from the conception that in two species the same character or organ in course of time becomes differently constructed from the genetical standpoint. We have a clear indication that a character or organ is not genetically in a static but is in a dynamic condition. The genes, as a manifestation of which the character develops, must be continually changing, according to whether their allelomorphs are selected to strengthen other physiological processes. There must be continual competition between different organs or functions for the selection of one or the other member of a pair of allelomorphs.

On the dynamic view of organs and functions we are able to see how organs such as the eye, which are common to all vertebrate animals preserve their essential similarity in structure or function, though the genes responsible for the organ must have become wholly altered during the evolutionary process, since there is now no reason to suppose that homologous organs have anything genetically in common.

The dynamic conception of the evolution of function serves also to explain the remarkable results obtained by Goldschmidt in his crosses between European and Japanese races of the Gipsy moth (*Lymantria dispar*). Goldschmidt obtained inter-sexes in these crosses, but explains the results on a theory involving the assumption of quantitative potencies of the sex genes.

It is simpler to assume that as a consequence of geographical isolation and different ecological environment, the whole sex mechanism becomes built up differently in the two widely separated areas. Thus on crossing there is mutual disintegration of the two sex mechanisms leading to the production of inter-sexes.

With these considerations I will close. The interpretations which I have placed upon our experimental results seem to me to be valid so far as the genus *Gossypium* is concerned. To what extent the processes demonstrated for *Gossypium* have occurred in other species and in other genera cannot be predicted, and cytological considerations in other genera must play a large part. We do seem, however, to have caught a glimpse of how Nature is working to produce new species in the inexhaustible material which she possesses, and in the enormous time which she has at her disposal.

FUNGUS PARASITE OF CALABASH.

A serious wilt disease of calabash is caused by the fungus *Corticium centrifugum*, which has recently been studied in detail by T. Watanabe (*Bull. Utsunomiya Agric. Coll.*, Japan, No. 3; 'Studies on some characters of *Corticium centrifugum*', pp. 1-16, and 'Vitality of *Corticium centrifugum*', pp. 17-28, July, 1933). The fungus grows on a wide variety of nutrient media, but produces sclerotia most readily on soy bean agar and apricot sugar. Asparagin agar and Richard's solution produced mycelial growth only. The fungus has an optimum temperature of 28°C. and attacks a wide variety of cultivated plants. Mycelia and sclerotia remained alive on the host plant and in the soil throughout the winter in Japan. The effect of many substances upon the fungus has been tried in the laboratory, and it appears easy to kill the parasite, but no field trials have as yet been undertaken.—(*Nature*, Vol. CXXXII, No. 3336, October, 1933.)

MISCELLANEOUS NOTES.

Amani Agricultural Research Station.

The fifth annual report (1932-1933) of the Amani Agricultural Research Station has been issued by the Colonial Office (London: *H.M. Stationery Office*. 1s. net), and in a covering letter attention is directed to the fact that this is "the first report since the Station has really got going and stood upon its own feet". Definite advances have been made along many lines of investigation, and although a programme of long-range research has been followed, some important results capable of immediate application have been obtained. An intensive study of the root system of coffee has revealed the fact that a close correlation exists between root distribution and the acidity gradient of the soil profile. Where the reaction is approximately neutral, a uniform dispersal of roots is found throughout the soil, but should a mildly acid or neutral layer overlie an acid subsoil, the roots will be restricted to the upper layer. This behaviour suggests an explanation of many long-standing problems with regard to coffee-growing. The sisal industry has hitherto been chiefly devoted to the manufacture of binder twine, but an extension of the uses of the fibre is now taking place which affords an opportunity to develop special lines to serve particular purposes. This has necessitated a systematic examination of sisal seedlings and seedling hybrids, in the course of which a hitherto undescribed species has been discovered. The latter shows marked superiority to sisal, the rate of growth being greater, and its fibre being both softer, finer, and with a greater tensile strength. There seems no reason to doubt that this species will either replace sisal to a considerable extent, or supplement it and facilitate the extension of its present uses. An account of the Amani Agricultural Research Station was given by its Director, Mr. William Nowell, before the Royal Society of Arts on 24th October.—(*Nature*, Vol. CXXXII, No. 3339, p. 672.)

* * *

Cocoa in Tanganyika.

Promising experiments, in the growing of cocoa are being carried out in Tanganyika, states the *Times* Nairobi correspondent. In 1931 the export was 127 cwt., and in 1932, 70 cwt. Tests have been made by a British chocolate manufacturer, who has made a very encouraging report. The product came from an estate in the Tanga district and the manufacturer ranked it among that of the five best cocoa producing estates in the world. He intimated his willingness to take considerable quantities of the Tanganyika product. Extended plantings and trials are now in hand to decide the limits of cultivation in the Eastern Usambara mountains and in the Uluguru and Turiani hills of Morogoro.

The Acting Director of Agriculture in a recent statement declared that the Criollo type was the most important to Tanganyika as a product selling at a high price for which there was an increasing demand owing to the diminishing supplies which resulted from its habit of crossing easily with more common varieties. Tanganyika was fortunate, however, in not having large areas of mixed types, and the control of new plantings to maintain a pure Criollo was under consideration. He added that the Eastern Usambara area, which produced coffee, tea, cocoa, cardamoms, spices, flavouring essences, and quinine, was "crying out for development". In a general reference to agriculture in the territory, he laid stress on the importance of encouraging the native peasant agriculturist to adopt mixed farming to safeguard him from the dangers of fluctuation in world prices.—(*African World*, Vol. CXXIV, No. 1613, 1933.)

* * *

Shea Nuts.

Attention is called in an article by H. W. Avis (*Food Manufacture*, VIII, 1933) to that somewhat neglected product, the Shea Nut. This, the fruit of *Butyrospermum Parkii*, is grown on the Gold Coast and in Nigeria, but is exported mainly from Nigeria, 7,433 tons of nuts valued at £45,619 being exported thence to Belgium and Holland in 1931. The fruit consists of an apple-green skin enclosing a soft fleshy layer which in turn contains the kernels. To extract the kernels for sun-drying the fruit is first boiled to remove the mesocarp and then spread in the sun for ten days to dry. After ten days the nuts are cracked between two stones, winnowed, and again sun-dried for ten days, by which time the moisture will have fallen from 40 per cent. to 7 per cent. If kiln-dried, the nuts are heated in a mud kiln for five days, the temperature not exceeding 90° C. at the top and 60° C. at the bottom. Nuts can arrive in Europe with a free fatty acid content of less than six per cent. and an oil content of over 46 per cent. The product as manufactured in Europe is a whitish, stiff, plastic fat, melting between 23°C. and 25°C. It can be separated into stearine and oleine. The supposed difficulty in refining this fat can be eliminated according to de Belsunce (*Bull. Matières Grasses*, 1926, Nos. 7 and 8; 1927, No. 1) by the following method. First the oil is steamed to remove the odour. Then it is treated with a solution of sodium carbonate and thereafter, when the soap stock has been removed, in the usual manner, being in this method finally bleached with persulphate. Properly refined shea butter will not easily go rancid. The cake after removal of the oil is high in carbohydrates and low in proteins, making a useful adjunct in a compound cattle-feeding cake. In one way or another the entire nut can be utlized.—(*Horticultural Abstracts*, Vol. III, No. 2, Ab. 252.)

THREAD BLIGHTS IN TRINIDAD.

By

H. R. Briton-Jones and R. E. D. Baker.

Introduction.

As far as can be gathered from the literature on the subject, all the true thread blights which affect plants in tropical regions and the U.S.A. belong to one of two genera, namely, *Marasmius* or *Corticium*. The present writers, in spite of diligent search, have not observed any of the fructifications of the several species of thread blights which occur on various plants in Trinidad. They will, nevertheless, in their reference to the different thread blights discussed in this paper, speak of those possessing the typical mycelium of the genus *Rhizoctonia* as *Corticium* thread blights; those with mycelia which answer to the descriptions of thread blights whose fructifications have, in all known cases, been referred to the genus *Marasmius* will be termed *Marasmioid* thread blights.

Several species of thread blights are known to occur in various countries of the Eastern and Western tropics. A fairly complete list of references is given in the appended table. (Appendix I.)

From the table it will be seen that Nowell (25) records *Corticium koleroga* on coffee and *Corticium Stevensii* on cacao, nutmeg and other plants in the British West Indies. Stell (32) records *Corticium koleroga* on coffee and *Corticium* sp. on cacao in Trinidad. Moreover, Martyn (19) states that in British Guiana, cacao is affected by *Corticium koleroga*. None of these workers mention any *Marasmioid* forms. On the other hand, Petch (26) has identified a species of *Marasmius* on cacao material collected in the British West Indies. Nowell's (24) figure 45 of cacao leaves affected by a thread blight identified as *Corticium Stevensii* is, in the light of the present writers' experience, without doubt a *Marasmioid* form.

Seasonal Effect on Thread Blights.

As is generally known, all the diseases which come under the term "Thread Blights" occur to a much greater extent under abnormally wet conditions in all the countries where they have been recorded. The extensive occurrence of thread blights in Trinidad during 1933 is due to the fact that the rainfall during the wet season was abnormally high. The rainfall recorded at this Institution in 1929 and 1930, which were normal years, and for 1933 is given in the following table and can be taken for general purposes as a comparison of the rainfall in these years in other parts of the island. Previous to 1933 thread blights in this island have been localised in their distribution and have generally been assisted by factors such as heavy shade, lack of drainage, and low-lying land, both in coffee and in cacao.

Rainfall.

	1929. Monthly Totals. ins.	1930. Monthly Totals. ins.	1933. Monthly Totals. ins.
January ..	1.40	3.62	4.11
February ..	0.70	1.04	0.74
March ..	0.70	0.61	1.23
April ..	0.92	2.34	1.74
May ..	7.46	2.07	5.68
June ..	10.35	6.97	12.42
July ..	9.65	8.83	12.53
August ..	9.45	4.03	11.16
September ..	5.59	5.71	12.33
October ..	2.78	8.61	8.22
November ..	7.88	2.57	7.68
December ..	1.25	5.88	9.51
Total ..	58.13	52.28	87.35

Trinidad Records in 1933.

As the several thread blights were found, their macroscopic characters were briefly described. Since it was not possible without further study to differentiate between them, they were given a number under the letter C or letter M according as to whether, after microscopical examination, the mycelium was found to answer to the *Corticium* or *Marasmioid* types.

M1 on Coffee (*C. arabica*) (Plate I).

Infrequent occurrence—collected once in each of the districts Caura, Guanapo, and Arima-Blanchisseuse. Threads white and shiny turning dark brown when old; they branch profusely on the leaf laminae but no pellicle is formed. Dead tissue on leaf at first limited to that in juxtaposition to the thread and thus producing characteristic brown streaks when leaf is examined from above. Hyphae fine, hyaline, irregular, rarely septate, measuring 3-4μ in diam. in the threads. Clamp connections present.

M2 on Coffee (*C. arabica*) (Plate II).

Rare—collected once in Caura. Threads rather indefinite, being covered by a sheet of white mycelium on both stems and leaves. Slight trace only of brown colour in old threads. Hyphae fine, hyaline, rarely septate, irregular up to 3μ in diam. in the threads. Clamp connections present. Similar in appearance to M3.

M3 on Grapefruit (Plate III).

Rare—collected once on the lowermost branches of grapefruit trees at Tamana.

Very similar to M2.

M4 on Cacao (Plates IV and V).

Comparatively rare—collected at Guanapo, Caura, and Mitan. Threads nearly always white and shining. Brown colour seldom seen. Threads branch profusely on leaf laminae but do not form a pellicle. Immature *Marasmius* fructifications found on leaf laminae near the threads but apparently not organically connected. Hyphae in threads fine, hyaline, rarely septate, irregular up to 3μ in diam. Clamp connections present.

M5 on Rose.

Found once at St. Augustine. Threads white, rather indefinite, tending to spread into a sheet of mycelium on both leaves and stems. Hyphae in threads fine, hyaline, rarely septate, irregular up to 3μ in diam. Clamp connections numerous.

M6 on Coffee (C. robusta).

Found at Mitan on stems and berries only, but it may occur on leaves. Threads dark brown when old but majority white and shiny. Threads definite and not forming a sheet of mycelium (pellicle). At first dead tissue limited to that in contact with the threads thus giving a characteristic appearance. Later caused death of berries. Very similar in behaviour and appearance to M1 on *C. arabica*. Hyphae typically *Marasmioid*. Almost certainly identical with M1 on *C. arabica*.

M7 on Coffee (C. robusta).

Collected at Mitan. Similar to M2 on *C. arabica* and M3 on grapefruit though the threads appeared to be a little more definite on the twigs. Mycelium typically white and showing but little tendency to turn brown with age.

C1 on Coffee (C. arabica).

Very common under moist conditions, *i.e.*, on bushes growing under cacao. Caused considerable damage especially in the Caura Valley. Threads dark brown with age, white when young, mycelium almost invisible when wet. When dry can be peeled off as thin buff to light brown continuous layer (pellicle). Hyphae in threads coarse, septate, coloured, regular, branching more or less at right angles, 7-10μ in diam. Mode of branching and general texture of mycelium resembling *Rhizoctonia solani*. No clamp connections.

C2 on Grapefruit.

Rare—found once at Tamana. Threads up to 1.5 mms. wide; almost white when young, soon turning brown. Forms pellicle which completely covers undersurface of leaves. Sclerotia present on leaves and stems; those on leaves small and those on stems vary in size up to 4.0 × 2.5 mms. No clamp connections.

C3 on Warszewiczia coccinea.

Common occurrence. Typical *Corticium* thread blight—mycelium whitish when young, dark brown when old. No sclerotia. No clamp connections. Forms pellicle. Similar to C1 (?).

C4 on Nutmeg.

Rare—found once in Arima-Blanchisseuse Valley. Threads up to 1 mm. wide thickening at the nodes so as to suggest sclerotia. They are whitish when young turning dark brown with age. Forms pellicle on undersurfaces of leaves. Sclerotia present, measuring up to 4 × 3 mms. Resembles C2.

C5 on Cacao.

Rare—found once in Caura. No sclerotia found. Threads whitish to brown and up to 1 mm. wide. Forms pellicle on undersurfaces of leaves. Very similar to C1 which was common on coffee growing under the affected cacao. (*Vide* cultural characters.)

C6 on Coffee (C. robusta).

Not common—found at Mitan causing serious damage to a few bushes. Also at Caura but doing little damage. Threads white when young soon turning dark brown and anastomosing frequently on the twigs. They measure about 1.5 mm. in diam. No true sclerotia. No clamp connections. Similar to C1.

C7 on Orange (Citrus sinensis).

Found once at Mitan but not causing serious damage. Threads almost invariably dark brown in colour even when young. They are slender, usually measuring less than 1 mm. in diam. No clamp connections. Forms pellicle.

C8 on Ixora coccinia.

Found once at Mitan. Threads rather fine, usually less than 0.5 mm. in diam. Dark brown in colour but lighter at the tips. Sclerotia present on stems—dark brown and 2-3 × 2-3 mms. Similar to C2 (?).

Fructifications.

In spite of the most diligent examination in the field and laboratory, extending over a period of six months, no fructifications, except those mentioned above under M4, have been found.

Inoculation Experiments.

In view of the fact that specific identifications were not possible in the absence of fructifications it was decided to make a comparative study of the different thread blights by means of infection experiments and cultural characters.

After considerable difficulty the following were isolated into pure culture—M1, 2, 3, 4, and 5, C1, 2, and 5. Continued attempts were made to bring into culture several of the others but without success.

Infection experiments were carried out with all the eight isolations mentioned above using in each case the mycelium in pure culture as inoculum, and cacao and Arabian coffee plants as hosts. The bamboo pots containing the young cacao and coffee plants (18-24 ins. in height)

were sprayed with water, inoculated by placing pieces of mycelium on the bases and laminae of some of the leaves, and then enclosed in glass cases, the sides and floors of which had been previously wetted so as to ensure a saturated atmosphere. In one of several such experiments the M types grew vigorously for a few days but before any discolouration became apparent the cacao plants lost all their leaves. In another experiment on cacao, C5, in the case of one leaf only, penetrated from one side of the leaf to the other without forming much extension growth on either side of the lamina. Several attempts were made by keeping the doors of the cases partially open for varying intervals to regulate the humidity so as to maintain an atmosphere damp enough for the growth of the inocula and at the same time to keep the humidity below saturation to avoid the plants becoming defoliated. All efforts, however, were unsuccessful. Wolf and Bach (36) have described successful infection experiments with *C. koleroga* by placing diseased material in contact with healthy, and wrapping with wet absorbent wool which was enclosed in paraffin paper. These workers were also successful using mycelium in pure culture as inoculum.

Bunting (9) also records both success and failure in experiments with diseased material of *Marasmius scandens* Massee on cacao on the Gold Coast. Others, like the writers, have failed to obtain positive results in inoculation experiments.

Cultural Characters.

When the eight isolations had been growing for a few days in culture certain differences were observed between individuals within both the series M and C. In order to make more critical observations it was decided to grow all under the same conditions on two standard media, namely, Brown's Synthetic Medium and Czapek's Medium, in accordance with the formulae shown in the table below.

Statistical Analysis.

All cultures were made in Petri dishes 9 cms. in diameter using the above two standard media. The experiment was carried out at a laboratory temperature of about 30°C. Inoculations were made with young mycelium from actively growing cultures.

In order to obtain adequate replication for statistical analysis, six cultures were made in each series and the increase in diameter of each colony was measured at intervals of 24 hours. It was found that the rate of growth of the colonies increased during the first three days of the experiment but later became constant. The readings taken on the first three days were therefore neglected in the statistical analysis. In making the calculations the readings for the 4th, 5th, and 6th days were taken together giving a total of 18 for each fungus under consideration.

The Standard Error of the mean increase in diameter of the colony in 24 hours was calculated, and the means were compared using Fisher's table of 't' for a probability of .05. Tables of the measurements made in this experiment will be found in Appendix II.

Interaction of Fungi.

In order to corroborate the results obtained by comparing growth rate and naked-eye characters it was decided to grow each of the fungi with the other members of their respective group, by sub-culturing into the same Petri dish and allowing one colony to grow towards the other. These were carried out on Czapek's Medium. Six replications were made in each series.

C1 and C2.

Colonies grew to meet each other. C1 colony much larger than C2. Mycelium of C1 more aerial and flocculent than C2. Quite different.

C1 and C5.

Colonies grew and met. About equal in size. Quite different in appearance as C1 had aerial mycelium while C5 had no aerial growth. C1 and C5 are different fungi.

C2 and C5.

Colonies met. C5 slightly larger than C2. C2 had a little aerial mycelium while C5 produced no aerial growth.

Different. Thus it is concluded that the three *Corticium* isolations are all different from each other.

Brown's Synthetic Medium.		Czapek's Medium.	
Glucose	2.0 grams	Sodium Nitrate	2.0 grams
Asparagin	2.0 ,,	Acid Pot. Phosphate	1.0 ,,
Pot. Phosphate	1.25 ,,	Mg. Sulphate	0.5 ,,
Mg. Sulphate	0.75 ,,	Pot. Nitrate	0.5 ,,
Agar	15.0 ,,	Ferrous Sulphate	0.01 ,,
Dist. Water	1,000 ccs.	Sucrose	30.0 ,,
		Agar	15.0 ,,
		Dist. Water	1,000 ccs.

M1 and M2.

Colonies did not meet. M1 especially exhibiting check in growth and M2 only slightly. Colony of M1 much larger and coarser looking than M2. No aerial mycelium in either. Mycelium of M2 closer and more compact than that of M1. Different.

M1 and M3.

Definite check in growth by M1. Colony of M1 larger than M3. No aerial mycelium. Mycelium of M3 closer and more compact than M1. Different.

M1 and M4.

Colonies met and about equal in size. One indistinguishable from the other. Same fungus.

M1 and M5.

Colonies met. M5 produced aerial mycelium where the colonies met and grew over the top of M1. Mycelium of M5 finer than that of M1 and more compact. Colonies about equal in size. Different.

M2 and M3.

Colonies met. No aerial mycelium. Both slow growing. Mycelium very compact in both cases. Same fungus.

M2 and M4.

Definite check in growth in both cases. M4 much larger than M2. Mycelium of M2 closer and more compact than that of M4. Different.

M2 and M5.

No check—colonies met. M5 produced aerial mycelium at point of contact and grew over M2. M5 much larger than M2. Different.

M3 and M4.

Slight check in growth. M4 larger than M3. Mycelium of M3 much closer and more compact than M4. Different.

M3 and M5.

No check in growth—colonies met. M5 produced aerial mycelium on meeting M3 and grew over it. M5 larger than M3. Different.

M4 and M5.

No check—colonies met. M5 produced aerial mycelium on meeting M4 and grew over it. Colonies about the same size. Different.

Thus it is concluded that M1 and M4 are the same fungus but different from M2 and M3 which are also identical but different from M5.

Fungi on Potato Blocks.

All the isolations were grown on potato blocks and examined when eight days old.

M5 differed from all the others in forming a hard and close felt of mycelium which was difficult to cut through with a sagittate needle. M1 and M4 were indistinguishable from each other and obviously different from M2 and M3 which grew much more slowly and produced much less aerial mycelium. M2 and M3 resembled each other so closely as to be indistinguishable one from the other.

It is thus again concluded that M1 and M4 are the same fungus but different from M2 and M3 which are themselves the same fungus. M5 makes a third fungus being quite distinct from the others.

C1 produced a white fluffy mass of aerial mycelium and covered the potato block, thus making it quite distinct from C2 and C3. C3 produced isolated irregular clumps of white fluffy aerial mycelium.

C2 produced no white fluffy mycelium and when in contact with the inside of the tube was darker brown in colour than C1 and C3. C1, C2, and C3 thus still retain their individuality as three separate fungi.

According to Narasimhan (24), Bavendamm found that the brown discolouration produced by some fungi growing on media containing tannic acid is caused by the action of the oxidase produced by the fungi on tannin. Narasimhan in his work on *C. koleroga*, used Bavendamm's test, and obtained indications of the presence of oxidase. It was thought possible that some of the isolations under discussion might show different reactions to such a medium but on trial all members of both the M and C series produced marked browning with no observable difference.

Identification.

Of the five *Marasmioid* isolations studied it has been shown that they include three separate fungi and in the light of experience in several different countries it is probable that these three belong to the genus *Marasmius*. Without fructifications a closer identification is not possible.

The three isolations of *Corticium* are different from one another but after careful comparison between the several descriptions (10, 26, &c.) of *Corticium koleroga* and *Corticium Stevensii* the writers identify C2 on grapefruit as *Corticium Stevensii*, Burt, and C1 on *Coffea arabica* as *Corticium koleroga* (Cooke) von Höhn. The presence of sclerotia in the former and their absence in the latter is of definite diagnostic value. The identity of C5 is unknown. It may be a strain of one of the other two or a separate species. Of the fungi which were not brought into pure culture it is considered fairly safe to identify C4 on nutmeg as *Corticium Stevensii* and C6 on *Coffea robusta* as *Corticium koleroga*, whereas the identity of C3, C7 and C8 remains unknown.

APPENDIX I.

Authors' Names.	Source of material.	Name of Thread blight.	Name of Host plants.	Date of publication	Reference.
1. Arbelaez, E. P.	Colombia	*Corticium koleroga*	Coffee, Orange, Lemon	1933	*Manual del Cafetero Colombiano, Federacion Nacional de Cafeteros, Bogota,* 1933.
2. Bally, W. ..	Dutch E. Indies	*Corticium* sp.	Coffee	1929	*Arch. voor Koffiecult, Nederl. Indie, III.* 1, pp. 1-24, 1929.
	do.	*Marasmius* sp.	Wild spp. of *Rubiaceae.*		do.
3. Bancroft, C. K.	Federated Malay States	..	Rubber, Cinnamon, *Psidium guyava*	1911	*Agric. Bull. Straits and Fed. Malay States,* X, pp. 110-114, 1911. (referred to by Petch, 26.)
4. Berkeley, M. J.	India	*Corticium repens*	Tea	1873	*Gard. Chron., No.* 24, 1873, pp. 810-811. (referred to by Petch, 26.)
5. do. ..	India	do. ?	Tea, *Andrachne trifoliata.*	1875	*Quart. Journ. Misc. Science,* XV, 1875, p. 131. (referred to by Petch, 26.)
6. Bernard, C. ..	Java	*Hypochnus theae*	Tea, Rubber	1907 —	*Bull. du Dept. Agric. aux Indes Neerlandaises,* No. VI, 1907. (referred to by Petch, 26.)
7. Boedijn, K. B.	Dutch E. Indies	*Marasmius* spp.	Rubber	1926	*Arch. voor Rubbercult. Nederl. Indie,* X, 8, pp. 369-376, 1926.
8. Brooks, F. T.	Malay	..	Rubber	1916	*Ann. App. Biol.,* II, pp. 209-227, 1916. (referred to by Petch, 26.)
9. Bunting, R. H.	Gold Coast	*Marasmius* sp.	Cacao, Coffee, Jak, Camphor, Kola, *Carpodinus hirsutus* (*Hua.*)	1917, 1918	*Ann. Rept. Dept. Agric. Gold Coast* (1917), 1918. (referred to by Petch, 26.)
10. Burt, E. A. ..	Puerto Rico	*Corticium koleroga* (Cke.) von Höhn.	Coffee	1918	*Ann. Miss. Bot. Gard.* Vol. V, 1918, pp. 119-132. (referred to by Petch, 26.)
	Brazil and U.S.A.	*Coticium Stevensii,* Burt	Apple, Pear, Quince		
	Trinidad	do.	*Codiaeum variegatum*		
11. Butler, E. J. ..	India	*Corticium koleroga*	Coffee	1918	Fungi and disease in plants. Calcutta, 1918. (referred to by Petch, 26.)
12. Cooke, M. C. ..	Mysore, India	*Pellicularia koleroga—C. koleroga*	Coffee	1876	*Popular Science Review,* 15, 1876, pp. 164-165. (referred to by Burt, 10.)
13. Coleman, L.C.	Mysore, India	*Corticium koleroga*	Coffee	1923	*Mysore State Dept. Agric. Mycol. Ser. Bull.* 5, 1923.
14. Cunningham, D. D.	India	*Corticium repens?*	Tea	1897	*Scientific Memoirs,* Medical Officers, Army of India. Pt. X, 1897, pp. 111 to 118. (referred to by Petch, 26.)

APPENDIX I.—*Continued.*

Authors' Names.	Source of material.	Name of Thread blight.	Name of Host plants.	Date of publication	Reference.
15. Ernst, A. ..	Venezuela	*Erysiphe scandens*—*Pellicularia koleroga*	Coffee	1878	Estudios sobre las Deformaciones, Enfermedades, y Enemigos del Arbol de Café in Venezuela, pp. 1-24, Caracas. (referred to by Burt, 10.)
16. Gardner, M. W.	Indiana, U. S. A.	*Rhizoctonia* sp.	*Quercus nigra*	1927	Indiana plant diseases, 1925, *Proc. Indiana Acad. Sci.* XXXVI (1926), pp. 231-247, 1927.
17. Kuyper, J.	Surinam	not *C. koleroga*	Coffee	1912	Recueil des Travaux Botaniques Néerlandais, IX, pp. 436-451, 1912. (referred to by Petch, 26.)
18. Lewton Brain, L.	Trinidad, St. Lucia	?	Cacao	1905	*West Indian Bulletin*, VI, pp. 85-94, 1905. (referred to by Petch, 26.)
19. Martyn, E. B. ..	Br. Guiana	*C. koleroga*	Cacao	1933	*Kew. Bull.* 2, 1933.
20. Massee, G. E. ..	India	*Stilbum nanum*—(*Marasmius pulcher* Petch).	Tea	1898	*Kew Bull.*, 1898, pp. 105-112. (referred to by Petch, 26.)
21. do. ..	Gold Coast	*Marasmius scandens* Massee	Cacao	1910	*Kew Bull.*, 1910, p. 1. (referred to by Petch, 26.)
22. do. ..	Malaya	*Cyphella heveae*	Rubber	1914	*Kew Bull.*, 1914, p. 158 (referred to by Petch, 26.)
23. Munro, D. G. and Sundararman, S.	India	*C. koleroga*	Coffee	1923	*Planters Chron.*, XVIII, 14, pp. 193 to 196, 1923.
24. Nowell, W. ..	B.W.I., Puerto Rico.	*C. Stevensii*	Cacao, Nutmeg, &c.	1926	Diseases of Crop Plants in the Lesser Antilles.
	Jamaica, Trinidad, Surinam, Venezuela, Colombia, Mysore.	*C. koleroga*	Coffee		
25. Narasimhan, M. J.	Mysore, India	*C. koleroga*	Coffee	1933	*Phytopathology*, Vol. 23, 1933, pp. 875-886.
26. Petch, T. ..	Sumatra	*Corticium* sp.	*Rubiaceae*	1924	*Ann. Roy. Bot. Gard. Peradeniya* (*Ceylon*), IX, 1, pp. 1-43, 1924.
	Java	*Corticium theae*	Tea		
	Sumatra	*Corticium* sp.	Tea		
	India	*Marasmius* sp.	Tea		
	Java	*Marasmius* sp.	Tea		
	Ceylon	*Marasmius* sp.	*Gymnosporangia emarginata* & *Strobilanthes* sp.		
	Ceylon	*Marasmius pulcher*, Petch—*Stilbum nanum*, Massee.	Tea, Nutmeg, *Beloperone oblongata*, *Garcinia ferrea*,		
	West Africa	*Marasmius scandens*, Massee.	Cacao, Kola, &c.		

APPENDIX I.—*Continued.*

Authors' Names.	Source of material.	Name of Thread blight.	Name of Host plants	Date of publication	Reference.
26. Petch, T. ..	Malay Ceylon West Africa Gold Coast West Indies	*Marasmius* sp. ? *Marasmius* sp. ? *Marasmius* sp.	Rubber *Garcinia cornea* Cacao, Kola Cacao Cacao		*Ann. Roy. Bot. Gard. Peradeniya* (*Ceylon*), IX, 1, pp. 1-43, 1924.
27. Petch, T. ..	Gold Coast	*Marasmius byssicola*, Petch.	Cacao, Kola	1928	*Trans. Brit. Myc. Soc.*, Vol. XIII, 1928, pp. 142-143.
28. Richards, R. M. ..	Malay	*Cyphella heveae*, Massee.	*Hevea*	1917	*Agric. Bull. Fed. Malay States*, V, p. 312, 1917. (referred to by Petch, 26.)
29. Schwarz, M. B.	Dutch E. Indies	*Marasmius* sp. ?	Mahogany, Teak	1926	*Korte. Meded. Inst. voor Plantenziekten*, 2, 1926.
30. Simmonds, H. W.	Fiji	*Corticium penicillatum* Petch.	Coconut	1925	*Fiji Dept. Agric. Bull.*, 16, 1925.
31. Steinmann, A.	Dutch E. Indies	*Marasmioid* type	Tea, Rubber, Nutmeg, Pepper (*P. nigrum*), *Desmodium heterocarpum*, *Nephrolepis hirsutula*, *Imperata arundinacea*, *Pomatocalpa* spp. Mahogany, Teak, *Gardenia*, *Robusta* Coffee.	1928	*Arch. voor Cacao Nederl. Indie*, Deel 2, pp. 44-47, 1928.
32. Stell, F. ..	Trinidad	*Corticium* sp. *C. koleroga*	Cacao Coffee	1927, 1928	*Ann. Rept. Dept. Agric. Trinidad and Tobago* for 1927, 1928 and 1929.
33. Stevens, F. L. & Hall, J. G.	N. America	*Hypochnus ochroleucus*, *Corticium Stevensii*	Apple, Pear, Quince	1909	*Ann. Myc.*, VII, 1909, pp. 49-59. (referred to by Petch, 26.)
34. Thompson, A.	Malay	*Marasmius* spp.	Coffee	1930	*Malayan Agric. Journ.*, XVIII, 12, p. 621, 1930.
35. Tunstall, A. C.	India	*Corticium* spp.	Tea	1923	*Quart. Journ. Indian Tea Assoc.*, 1923.
36. Watt, G. & Mann, H. H.	India		Tea	1903	The pests and blights of the tea plant; 2nd Ed. Calcutta, 1903. (referred to by Petch, 26.)
37. Wolf, F. A. & Bach, W. J.	Florida	These authors consider *C. koleroga* and *C. Stevensii* to be synonymous, the present writers do not accept this.	Apple, Pear, Grapefruit, Orange, Pecan (*Hicoria* (*Carya*) *Pecan*), Pomegranate, *Aleurites fordii*, *Sapindus utilis*, *Diospyros virginiana*, *Pistachia chinensis*, Fig, *Ampelopsis* (*Parthenocissus*) *quinquefolia*, Sour Orange, (*Citrus bigaradii*), and Rose.	1927	*Phytopath.*, 17, pp. 689-709, 1927.

APPENDIX I.—*Continued.*

Authors' Names.	Source of material.	Name of Thread blight.	Name of Host plants.	Date of publication	Reference.
38. Zimmermann, A.	Java	*Marasmius* sp.	Coffee	1904	Eenige pathologische en physiologische waarnemingen over Koffie. *Meded. uit 'slands Plantentuin*, LXVII, 1904. (referred to by Petch, 26.)

APPENDIX II.

M1 Brown's Synthetic Medium.

Date and time of inoculation 11 a.m. 31-10-33.

Culture No.	1 p.m. 1-11-33	1 p.m. 2-11-33	1 p.m. 3-11-33	1 p.m. 4-11-33	1 p.m. 5-11-33	1 p.m. 6-11-33
1	7	11.5	14	19	24	30.5
2	5	9.5	14	22	33	41
3	4	9.5	15	23	32.5	43
4	8	16	24	32.5	42.5	50.5
5	7	16.5	24	35	47	56
6	7	9	13.5	20	27	34
Mean increase in diameter in 24 hrs.	6.3	5.67	5.58	7.83	9.08	8.17

Increase in diameter of Colony in 24 hrs.= 8.36 mm.
Standard deviation = 2.03
Standard error = 0.478.

M2 Brown's Synthetic Medium.

Date and time of inoculation 11 a.m. 31-10-33.

Culture No.	1 p.m. 1-11-33	1 p.m. 2-11-33	1 p.m. 3-11-33	1 p.m. 4-11-33	1 p.m. 5-11-33	1 p.m. 6-11-33
1	7	10	14	20.5	25	32.5
2	9	15	19	25.5	32.5	38
3	7	12	16	23.5	27	33.5
4	9	16.5	21	28.5	36	43
5	7	11	16	22.5	31	36
6	6	11	15.5	21.5	29	35
Mean increase in diameter in 24 hrs.	7.5	5.08	4.33	6.75	6.42	6.25

Mean increase in diameter of Colony in 24 hrs.= 6.44 mm.
Standard deviation = 1.24
Standard error = 0.293.

M3 Brown's Synthetic Medium.

Date and time of inoculation 11 a.m. 31-10-33.

Culture No.	1 p.m. 1-11-33	1 p.m. 2-11-33	1 p.m. 3-11-33	1 p.m. 4-11-33	1 p.m. 5-11-33	1 p.m. 6-11-33
1	7	12	15.5	22	27.5	32
2	4	8.5	11	16	21	26
3	6	9	13.5	20	24.5	30
4	6	10.5	13	18	26	31.5
5	5	9	11.5	14	18	21
6	7	12.5	19	25	30.5	36
Mean increase in diameter in 24 hrs.	5.8	4.4	3.67	5.25	5.42	4.83

Mean increase in diameter of Colony in 24 hrs.= 5.17 mm.
Standard deviation = 1.26
Standard error = 0.294.

THREAD BLIGHTS IN TRINIDAD.

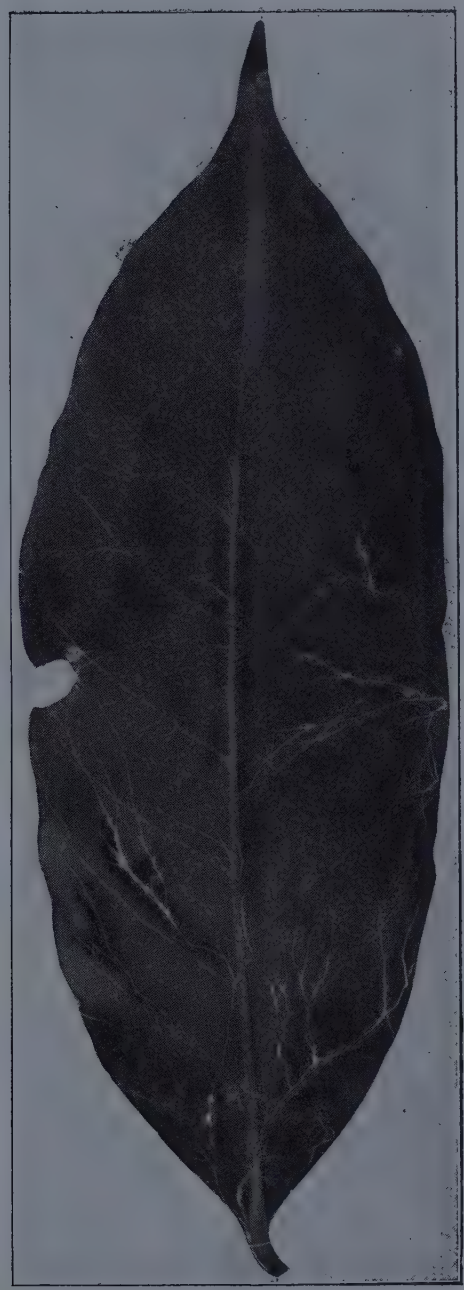

PLATE I.—M1 on *Coffea arabica*.

THREAD BLIGHTS IN TRINIDAD.

PLATE II.—M2 on *Coffea arabica*.

THREAD BLIGHTS IN TRINIDAD.

PLATE III.—M3 on Grapefruit.

THREAD BLIGHTS IN TRINIDAD.

PLATE IV.—M4 on Cacao.

THREAD BLIGHTS IN TRINIDAD.

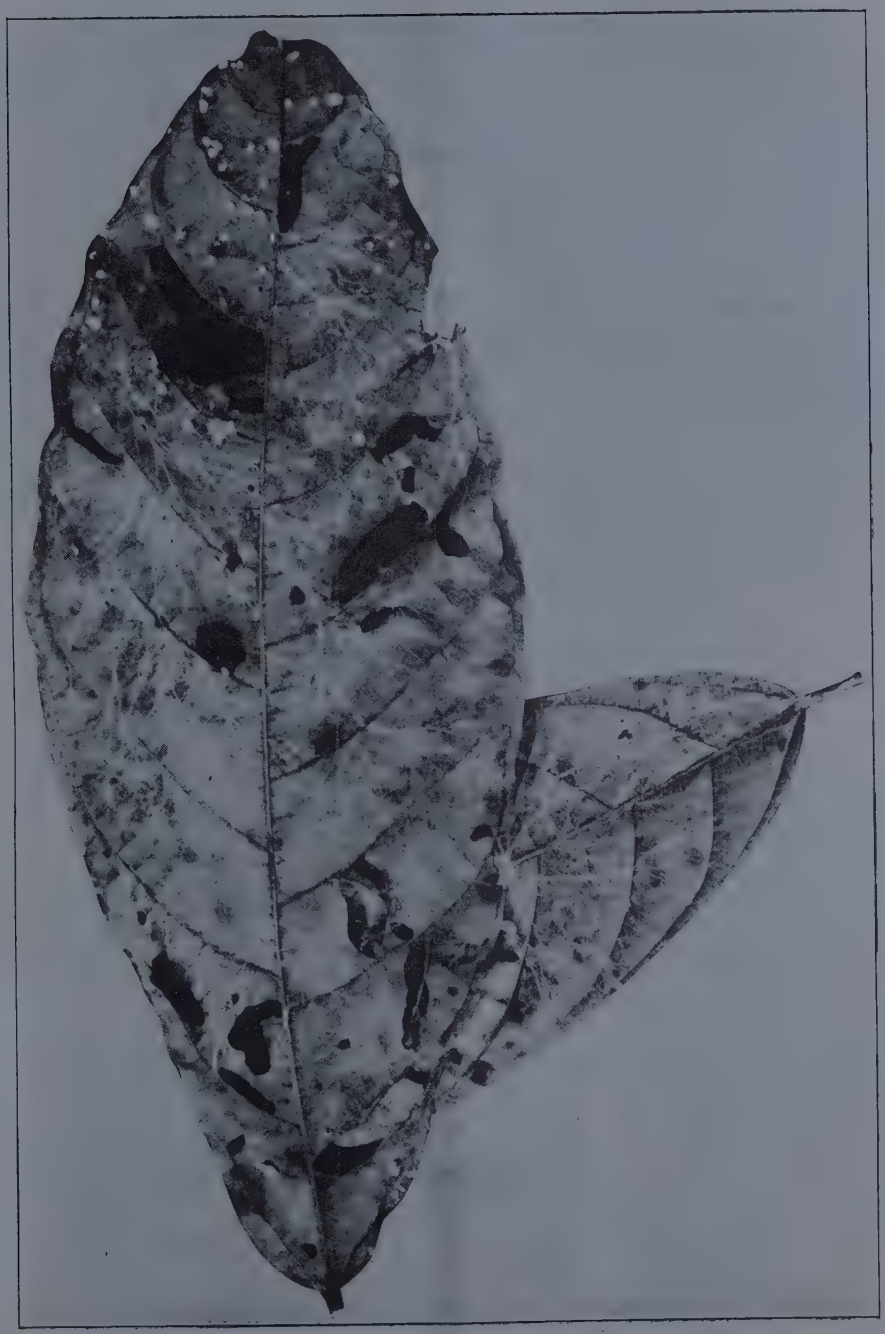

PLATE V.—M4 on Cacao.

THREAD BLIGHTS IN TRINIDAD.

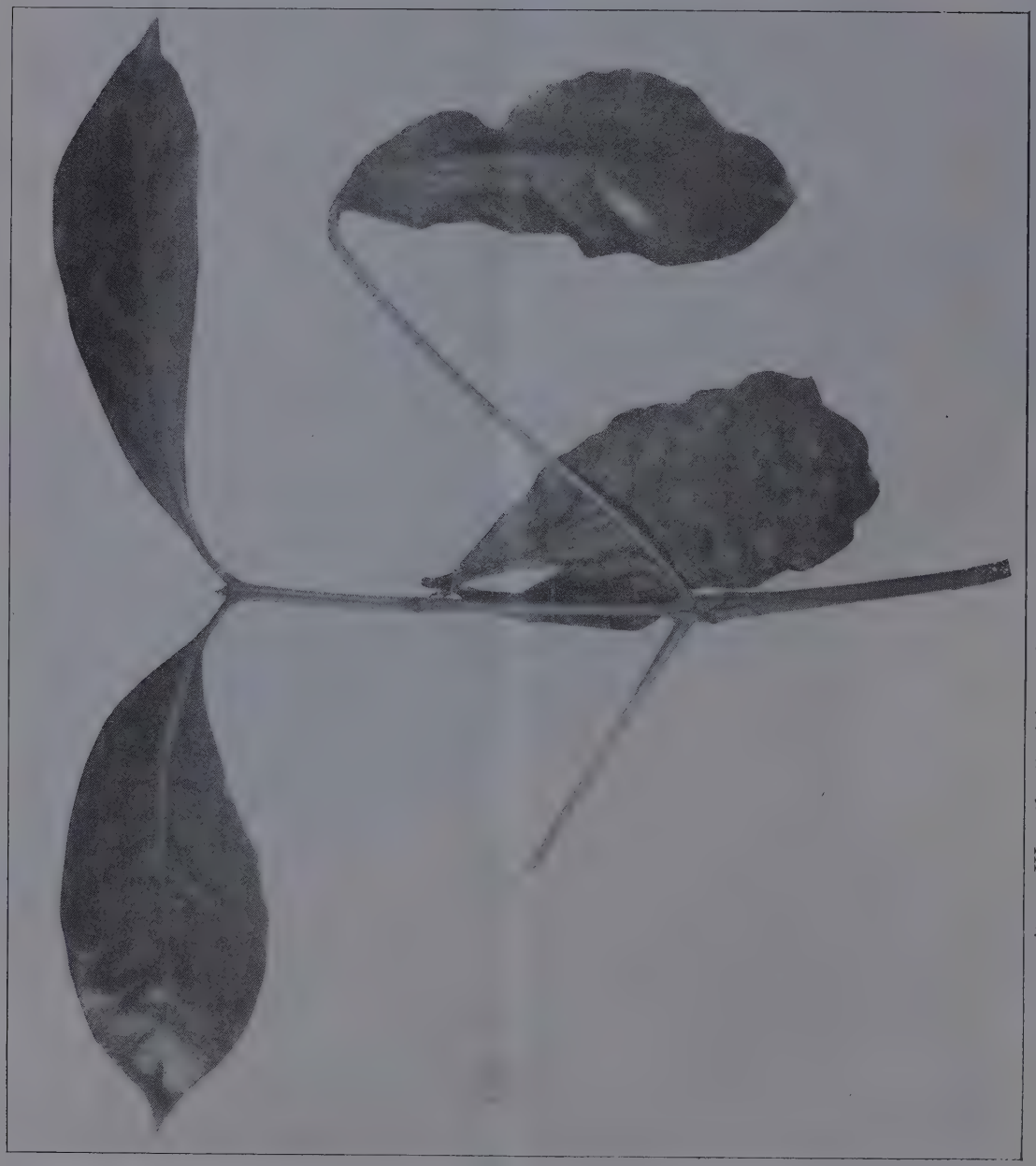

PLATE VI.—Cl (*Corticium koleroga* (Cooke) v. Höhn) on *Coffea arabica*.

OTHER FUNGOUS DISEASES IN TRINIDAD

PLATE VII.—Pink Disease (*Corticium salmonicolor* Berk. & Broome) on Grapefruit.

OTHER FUNGOUS DISEASES IN TRINIDAD.

PLATE VIII.—*Septobasidium* sp. on Grapefruit.

PLATE IX.—*Septobasidium* sp. on branch and leaves of Grapefruit.

APPENDIX II.—*Continued.*

M4 Brown's Synthetic Medium.

Date and time of inoculation 11 a.m. 31-11-33.

Culture No.	1 p.m. 1-11-33	1 p.m. 2-11-33	1 p.m. 3-11-33	1 p.m. 4-11-33	1 p.m. 5-11-33	1 p.m. 6-11-33
1	7.5	15	24	32.5	43	50
2	7	14.5	23.5	33.5	43.5	54
3	8.5	17	24	37	46	56
4	8	14	22	32	40	47.5
5	8	15.5	19	28	36	46
6	7	13.5	21	33	43	53
Mean increase in diameter in 24 hrs.	7.7	7.08	7.5	10.42	9.25	9.18

Mean increase in diameter of Colony in 24 hrs. = 9.61 mm.
Standard deviation = 1.50
Standard error = 0.3535.

M5 Brown's Synthetic Medium.

Date and time of inoculation 11 a.m. 31-11-33.

Culture No.	1 p.m. 1-11-33	1 p.m. 2-11-33	1 p.m. 3-11-33	1 p.m. 4-11-33	1 p.m. 5-11-33	1 p.m. 6-11-33
1	6	11.5	16.5	27	38	50
2	7	13	18	30	40	54.5
3	8	14	18	28.5	39	52
4	6	12	17	26	36	47.5
5	6	10.5	17	28	38	49
6	6	10.5	16	25	35	48.5
Mean increase in diameter in 24 hrs.	6.5	5.42	5.17	10.33	10.25	12.58

Mean increase in diameter of Colony in 24 hrs. = 11.00 mm.
Standard deviation = 1.47
Standard error = 0.346.

NOTE.—Colony forms a close mass of hyphae which is not easily differentiated from the medium with the naked-eye. This is quite different from the others in Series M.

C1 Brown's Synthetic Medium.

Date and time of inoculation 11 a.m. 31-10-33.

Culture No.	1 p.m. 1-11-33	1 p.m. 2-11-33	1 p.m. 3-11-33	1.p.m. 4-11-33	1 p.m. 5-11-33	1 p.m. 6-11-33
1	9	19	30	43.5	58	69
2	9	21	32	44	58	71.5
3	11	25	35.5	49	63	72
4	13	27	38	52	66	79
5	8	17.5	31	43	55	69
6	7.5	18	31	43	56	68
Mean increase in diameter in 24 hrs.	9.6	11.67	11.67	13	13.58	12.08

Mean increase in diameter of Colony in 24 hrs. = 12.90 mm.
Standard deviation = 1.428
Standard error = 0.34.

NOTE.—Colonies show slight diurnal zonation.

APPENDIX II.—*Continued.*

C2 Brown's Synthetic Medium.

Date and time of inoculation 11 a.m. 31-10-33.

Culture No.	1 p.m. 1-11-33	1 p.m. 2-11-33	1 p.m. 3-11-33	1 p.m. 4-11-33	1 p.m. 5-11-33	1 p.m. 6-11-33
1	13.5	27	39	54	67.5	79
2	9	23.5	35	49	62.5	75
3	8.5	21	30.5	43	55.5	69
4	15.5	29	41.5	56.5	65.5	83
5	11	22	33	46	59	72
6	13	26	37.5	51.5	63	76
Mean increase in diameter in 24 hrs.	11.75	13.00	10.83	13.92	12.17	13.5

Mean increase in diameter of Colony in 24 hrs. = 13.19 mm.
Standard deviation = 1.74
Standard error = 0.41.

NOTE.—Showing marked diurnal zonation.

C5 Brown's Synthetic Medium.

Date and time of inoculation 11 a.m. 31-10-33.

Culture No.	1 p.m. 1-11-33	1 p.m. 2-11-33	1 p.m. 3-11-33	1 p.m. 4-11-33	1 p.m. 5-11-33	1 p.m. 6-11-33
1	7.5	14.5	21.5	33	46	58.5
2	9	17	26	39	54	67
3	7	13	20.5	31	44	..
4	8	14.5	22.5	34	47	59
5	8.5	16.5	25	36.5	52	65
6	8	15	21	34	48	59
Mean increase in diameter in 24 hrs.	8	7.33	7.67	11.83	13.83	12.3

Mean increase in diameter of Colony in 24 hrs. = 12.55 mm.
Standard deviation = 1.225
Standard error = 0.29.

NOTE.—Slight diurnal zonation.

M1 Czapek's Medium.

Date and time of inoculation 11 a.m. 31-10-33.

Culture No.	1 p.m. 1-11-33	1 p.m. 2-11-33	1 p.m. 3-11-33	1 p.m. 4-11-33	1 p.m. 5-11-33	1 p.m. 6-11-33
1	7	13.5	20	29	38	45
2	6	14	21.5	33	40	47
3	8	16	25	35	45	53
4	5.5	10.5	16.5	20	23.5	28
5	7	13	24	34	43	53
6	6	11	17	25	33	39
Mean increase in diameter in 24 hrs.	6.6	6.42	7.83	8.67	7.75	7.08

Mean increase in diameter of Colony in 24 hrs. = 7.83 mm.
Standard deviation = 2.31
Standard error = 0.54.

APPENDIX II.—*Continued.*

M2 Czapek's Medium.

Date and time of inoculation 11 a.m. 31-10-33.

Culture No.	1 p.m. 1-11-33	1 p.m. 2-11-33	1 p.m. 3-11-33	1 p.m. 4-11-33	1 p.m. 5-11-33	1 p.m. 6-11-33
1	6	10.5	14.5	20	25.5	30
2	5	11	16	22	27.5	33
3	6	13	18.5	25	34	40.5
4	6	9.5	13.5	16	18	23.5
5	6	12.5	16	24	28.5	33
6	5.5	10.5	15.5	21	25	31.5
Mean increase in diameter in 24 hrs.	5.75	5.42	4.5	5.67	5.08	5.5

Mean increase in diameter of Colony in 24 hrs. = 5.42 mm.
Standard deviation = 1.71
Standard error = 0.40.

M3 Czapek's Medium.

Date and time of inoculation 11 a.m. 31-10-33.

Culture No.	1 p.m. 1-11-33	1 p.m. 2-11-33	1 p.m. 3-11-33	1 p.m. 4-11-33	1 p.m. 5-11-33	1 p.m. 6-11-33
1	5.5	9.5	15.5	21	28	34
2	7	13.5	20	26.5	33	40
3	6	10.5	16.5	23	28.5	34
4	6	11	17	24	31.5	38
5	7.5	13	18	25	33.5	39
6	6.5	12	18	24	29.5	36
Mean increase in diameter in 24 hrs.	6.4	5.17	6	6.42	6.75	6.17

Mean increase in diameter of Colony in 24 hrs. = 6.44 mm.
Standard deviation = 0.82
Standard error = 0.19

M4 Czapek's Medium.

Date and time of inoculation 11.am. 31-10-33.

Culture No.	1 p.m. 1-11-33	1 p.m. 2-11-33	1 p.m. 3-11-33	1 p.m. 4-11-33	1 p.m. 5-11-33	1 p.m. 6-11-33
1	7	15.5	23	32	39	46
2	8.5	17.5	25.5	34	41.5	49
3	9.5	19.5	26.5	35.5	44	51
4	9	14	21	31	38	44
5	9	18	24	34	41	48
6	9.5	17	24	34	41	49
Mean increase in diameter in 24 hrs.	8.75	8.17	7.08	9.42	7.33	7.08

Mean increase in diameter of Colony in 24 hrs. = 7.94 mm.
Standard deviation = 1.24
Standard error = 0.29.

NOTE.—Closely resembling M5.

APPENDIX II.—*Continued.*

M5 Czapek's Medium.

Date and time of inoculation 11 a.m. 31-10-33.

Culture No.	1 p.m. 1-11-33	1 p.m. 2-11-33	1 p.m. 3-11-33	1 p.m. 4-11-33	1 p.m. 5-11-33	1 p.m. 6-11-33
1	9	14	21	32	39	50
2	9	14	20	30	37.5	44
3	9	14	20.5	29	39	46
4	9	14.5	20	33	37.5	49
5	8	13	19	28.5	36	44.5
6	6.5	14	19.5	29	37	46
Mean increase in diameter in 24 hrs. ..	8.4	5.5	5.92	10.25	7.42	8.92

Mean increase in diameter of Colony in 24 hrs. = 8.86 mm.
Standard deviation = 2.07
Standard error = 0.49.

NOTE.—Very like M4. The most difficult to differentiate from the medium.

C1 Czapek's Medium.

Date and time of inoculation 11 a.m. 31-10-33.

Culture No.	1 p.m. 1-11-33	1 p.m. 2-11-33	1 p.m. 3-11-33	1 p.m. 4-11-33	1 p.m. 5-11-33	1 p.m. 6-11-33
1	9.5	19.5	29	40	51	61
2	10.5	19	29	40	51.5	63
3	14	24	34.5	45	55.5	68
4	10.5	20	29	40	52	63
5	11.5	20.5	31	41	52	65
6	11	20	31	41	55	67
Mean increase in diameter in 24 hrs.	11.2	9.42	10.08	10.58	11.67	11.67

Mean increase in diameter of Colony in 24 hrs. = 11.305 mm.
Standard deviation = 1.07
Standard error = 0.25.

NOTE.—Showing zonation but not marked as in C2. on Brown's and similar to C2 on Czapek's Medium.

C2 Czapek's Medium.

Date and time of inoculation 11 a.m. 31-10-33.

Culture No.	1 p.m. 1-11-33	1 p.m. 2-11-33	1 p.m. 3-11-33	1 p.m. 4-11-33	1 p.m. 5-11-33	1 p.m. 6-11-33
1	15	26	37	48.5	60.5	72
2	13	24	34	45.5	58	70
3	14.5	25	35.5	47	57.5	70
4	13	24	33	43	56	67.5
5	12.5	22	31.5	42	54	65
6	12.5	23	31.5	42.5	53	65
Mean increase in diameter in 24 hrs.	13.4	10.58	9.75	11	11.83	12.08

Mean increase in diameter of Colony in 24 hrs. = 11.66 mm.
Standard deviation = 0.89
Standard error = 0.21.

NOTE.—Showing zonation but not so marked as C2 on Brown's Medium.

C5 Czapek's Medium.

Date and time of inoculation 11 a.m. 31-10-33.

Culture No.	1 p.m. 1-11-33	1 p.m. 2-11-33	1 p.m. 3-11-33	1 p.m. 4-11-33	1 p.m. 5-11-33	1 p.m. 6-11-33
1	12	22	30.5	41	53	67
2	9	16.5	25.5	36	49	61.5
3	12	21.5	31.5	40.5	49	61
4	10	18	25.5	35.5	45.5	59
5	9.5	18	26.5	35	47	56
6	11	20	27.5	38.5	51	64
Mean increase in diameter in 24 hrs.	10.6	8.75	8.5	9.92	11.17	12.3

Mean increase in diameter of Colony in 24 hrs. = 11.14 mm.
Standard deviation = 1.74
Standard error = 0.41.

NOTE.—No zonation.

NOTES ON SOME OTHER FUNGOUS DISEASES IN TRINIDAD, 1933.

BY H. R. BRITON-JONES AND R. E. D. BAKER.

As stated in the foregoing article "Thread Blights in Trinidad" the rainfall in this island from June onwards was exceptionally high. Under these conditions of rainfall and high atmospheric humidity certain diseases, which are of rare occurrence or previously unrecorded, became prevalent.

I.—*Septobasidium* sp. ON GRAPEFRUIT.

A fungus of the genus *Septobasidium* has been observed on grapefruit trees in three districts, namely, Maqueripe, Tamana and Diego Martin. In the two first named districts it occurred on individual branches on a few trees only and did not cause much damage. In Diego Martin, where conditions were much wetter, its occurrence on the trees was general and it caused defoliation and death in several branches under an inch in diameter (Plate IX). On the larger branches and on the trunks of the trees it caused longitudinal splits in the bark up to six inches in length. According to Fawcett and Lee (2) species of the genus *Septobasidium* have been found encircling the twigs, small branches, and extending to the petioles of the leaves in Florida, Cuba, Brazil and Formosa. Burt (1) in his monograph on the genus describes *S. lilacinum* as having been found by Thaxter on bark at Maraval, Trinidad. A comparison of Burt's descriptions of the several species of *Septobasidium* suggests that the fungus found by the writers on grapefruit trees is *S. pseudopedicellatum* (Burt). This statement is, however, based on general characters including colour and not on spore measurements. The writers have failed to find any spore-bearing specimens and until the fructifications can be microscopically examined the specific identification of the species affecting grapefruit in Trinidad must remain in doubt.

Fawcett and Lee (2) in their account of *Septobasidium* spp. on citrus state that the fungus "is entirely on the surface and does not appear to penetrate the bark. It appears to harm the twig only indirectly. Twigs with this enveloping band often appear normal and healthy. A species of scale insect, however, is found under this coating of the bark and probably lives in a symbiotic relation with the fungus. The fungus probably furnishes protection to the insects, while they, in turn, probably furnish secretions favourable to the growth of the fungus".

The writers' observations in Maqueripe and Tamana agree with those of Fawcett and Lee (2) in regard to the unimportance of *Septobasidium* sp. as a parasite because it did not cause sufficient damage even to justify the pruning out of the affected branches, which is recommended as a control measure by these authors. On the other hand, in no district was the fungus associated with scale insect infestation so that the question of symbiotic relationship does not arise. Under the very wet conditions prevailing in the grove at Diego Martin, however, the fungus grew luxuriantly on the trunks, main limbs, smaller branches and leaves of the grapefruit trees. In one case a main branch measuring about six inches in diameter was completely encircled with the fungus for a length of four feet. The defoliation and subsequent death of branches less than one inch in diameter was by no means infrequent. Moreover, there is no previous record of any species of *Septobasidium* producing rhizomorphs on branches (Plate VIII) so that the favourable conditions at Diego Martin may be considered unique.

Since grapefruit is a crop which is now being extensively grown in Trinidad further observations will be made on this disease.

II.—*Rhizoctonia solani* Kuehn ON BRIAR ROSE.

This is a fungus which usually attacks the roots and bases of the stems of its very numerous host plants. It is seldom that it attacks the aerial parts of plants. This year it has been found attacking and killing the leaves of briar rose cuttings which were being propagated as stocks. At first it was thought to be a thread blight since it formed a weft of mycelium on the surface of the attacked leaves which was similar to that produced by a *Corticium* thread blight, and the presence of sclerotia suggested *C. Stevensii*. The mycelium of a *Corticium* thread blight is a *Rhizoctonia* and the perfect stage of *R. solani* is *Corticium vagum*, B. & C. But in the absence of fruit bodies specific identification could not be based on microscopical examination of the fungus on the host plant. In culture the fungus grew much more rapidly (increase of diameter of colony was at the rate of 40 mms. in 24 hours) than the isolations of the true *Corticium* thread blights dealt with in the foregoing article and its identity was established.

A possible explanation of the source of infection in these cases is from soil splashed on to the aerial portions of the plants by the exceptionally heavy showers during the summer.

III.—PINK DISEASE *Corticium Salmonicolor* Berk. and Broome ON GRAPEFRUIT.—(Plate VII.)

This is of rare occurrence and as in the case of its previous record on the same host in 1930 its presence is correlated with wet conditions. Pink disease can cause considerable damage to the bark of grapefruit trees and, moreover, affected branches become defoliated and finally killed. In districts known to be subjected to heavy rainfall the full interval of 30 feet between trees should be given to allow of the free passage of air between the trees which minimises the losses caused by this disease, *Septobasidium* sp., and Gummosis.

IV.—*Sclerotium Rolfsii* Sacc.

This is a fungus which attacks and kills individual plants in several crops every year but since it is largely dependent on wet conditions, it has been found growing during this year on a number of economic plants including—sugar-cane, citrus, tomato, sword-bean (*Canavalia ensiformis*), *Tephrosia purpurea*, Sunflower, *Crotalaria usaramoenis*, soy-bean, banana (*M. cavendishii*), *Phaseolus aureus*, and *Phaseolus vulgaris*. The fungus caused a wilting of all the above plants except sugar-cane and banana on which it had caused no apparent damage.

Bibliography.

1. Burt, E.A.—The Thelephoraceae of North America. Septobasidium. *Ann. Miss. Bot. Gdn.*, Vol. III, pp. 319-343, 1916.

2. Fawcett, H. S. and Lee, H. A.—Citrus Diseases and their Control. *McGraw Hill Book Company*, New York. 1926.

CITRUS NOTE.

Oil Glands of Citrus Fruits as an Avenue of Infection.

In the course of certain inoculation experiments with *Penicillium digitatum* into freshly picked oranges through needle punctures, it was observed that occasional fruits failed to decay. Closer inspection of these fruits showed that the punctures had all been made between the oil glands, and that in no case had a single gland been ruptured.

Repeated experiments showed that both shallow and deep needle inoculations into oil glands caused from 80 to 100 per cent. of the fruits to decay. Deep wounds between the oil glands rarely permitted infection, whilst with shallow wounds the degree of infection was negligible.

To test the toxicity of the oil alone towards the spores of some common orange-rotting fungi, a small quantity of oil, extracted by the sponge process from Valencia oranges, was placed in test tubes together with a heavy inoculum of spores. Duplicate series were held at constant temperatures of 39° and 67°F. Small loopfuls of the suspension were removed at intervals and spread on hardened prune agar in petri dishes.

The thin-walled spores of *Oospora citri-aurantii* and *Colletotrichum gloeosporioides* were killed instantaneously by the oil at both temperatures. Spores of *Penicillium digitatum*, however, germinated after about seven hours' but not after eight hours' treatment at 67°F. Germination was markedly retarded though not inhibited after fifty hours' treatment at 39°. *P. italicum* spores were affected in approximately the same manner as those of *P. digitatum*.

It does not appear to have been noticed previously that the oil glands of citrus fruits provide a favourable avenue for infection by *Penicillium*. That they do so further emphasises the necessity for the utmost care during the handling of citrus fruits.—(C. R. Bates. *Nature*, Vol. CXXXII, No. 3341, 1933, p. 751.)

AGRICULTURAL NOTE BOOK.

Copies of Professor Wood's "Note-Book of Tropical Agriculture" (price 5 shillings) may be obtained on application to the Editor, *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

AGRICULTURAL WEALTH FROM WASTE. ACTIVATED COMPOSTS.

By Rudolph. D. Anstead, M.A., C.I.E.,
Retired Director of Agriculture, Madras Presidency, Southern India.

Introduction.

In 1842 Lawes took out a patent for the manufacture of superphosphate, and on 15th April, 1845, Liebig took out, through John Muspratt, an English patent "to restore to the land by means of a manure the mineral elements taken away by the crop which has been grown on and removed from the latter", and the science of agricultural chemistry was born.

The ideas of chemical treatment of the soil which flourished in the days of Lawes and Gilbert have gradually changed in view of more recent work, begun by Russell and Hutchinson, and followed up by hundreds of other workers all over the world, on the bacterial activities going on in the soil. The whole problem has been lifted from the realms of pure chemistry into that of biology. This new outlook includes in its horizon the possibility of utilising waste materials, such as sewage and town refuse, and causing them to pass once more round the carbon-nitrogen cycle, the plant-animal-bacteria-plant cycle, on which nature builds her system of life. Agriculture is becoming more and more dependent upon biochemistry.

The question which the early pioneers set themselves to answer was this: can farmyard manure be replaced by any other kind of manure supplying the same quantities of plant food in mineral form? The classical experiments at Rothamsted, on Broadbalk Field, showed that farmyard manure produced an average acre yield of wheat over a fifty year period of 35.6 bushels. This could be approximated, or even equalled, by the use of mineral fertilisers, more especially ammonium salts. Such results have been confirmed by similar experiments carried out on experiment stations in many places, and it began to look as if it was simply a question of economics. If mineral fertilisers can be made cheaply they should be able to replace farmyard manure. The practical farmer, however, was never quite satisfied about this and he doubted whether the fertility of the soil could be *maintained* without liberal applications of dung. The physical texture of the soil was apt to be altered, to its detriment, by the constant application of mineral fertilisers.

There is an increasing mass of evidence to show that even crop yields cannot be maintained indefinitely by the use of artificial and mineral fertilisers alone, and that it is essential to maintain the humus content of the soil. This does not mean that the use of mineral fertilisers should be abandoned, or their use neglected. There can be no doubt but that their cheapness, and the facility with which they can now be obtained, has been of incalculable value to agriculture. It is of the utmost importance that such fertilisers should continue to be produced and methods devised to make them still cheaper and more readily obtainable. At the same time, it is becoming more and more apparent that their correct use is as a supplement to organic manures, and that the supply of the latter must also be increased.

It is of interest to note that sugar-cane is a crop which occupies a special position in this respect. There is evidence to show that the use of mineral fertilisers increases the root system of the cane to a marked extent, and these roots being left in the soil gradually accumulate a store of organic matter. A great deal of trash is also returned to the soil. In the case of crops with a small root range, however, and where grain and straw are both removed, this method of accumulating organic matter does not hold good.

Vitamins.

With the discovery of vitamins and their importance in nutrition and general health still further importance has been given to the necessity for an adequate supply of organic manure. The animal obtains its necessary vitamins from the plants which it uses for food, and the plant manufactures these vitamins, or actually obtains them, from the soil. Work done in recent years by biologists and medical scientists has shown that, though actual crop yields may be satisfactory, the grain produced by the use of mineral fertilisers only is deficient in vitamins, and that therefore this system of manuring is not desirable. The risk is run of producing grain which is of low food value and the general health of the people may be lowered.

An examination of the grain produced on the permanent manurial plots at the Agricultural College Farm at Coimbatore in South India showed that after a time the composition differed from plot to plot. It was then discovered that if the grain from differently manured plots was used for seed purposes, and sown on a soil of ordinary fertility, the resulting crops were very different. The seed obtained from the plot manured continuously with farmyard manure gave a very much better crop than the seed obtained from the plots manured continuously with minerals only, or those not manured at all. The seed in fact loses its vital power of producing good plants and a good crop unless it has been produced on land manured with organic fertilisers. This surprising result was checked by constant repetition and has now been confirmed by workers in England and other countries.

The differences go still further than this. Lieut. Col. McCarrison, an authority on deficiency diseases in India, carried out some experiments with the grain produced on the different plots in the manurial series at Coimbatore. He discovered that while the grain from the plots manured continuously with farmyard manure was quite good normal food, the grain from the plots manured continuously with minerals only lacked

growth vitamins, and animals fed with it failed to develop and soon died, and that in this respect it was as bad as the grain produced on plots left continuously unmanured. From this it was inferred that the plant obtains its vitamins from the organic matter in the soil, and that vitamin content is intimately connected with manurial treatment. This was quite a new idea, but the results have been not only confirmed by workers in other countries, but have also been discovered independently.

This means that mineral fertilisers, valuable as they are, cannot altogether replace organic manures, and that unless an adequate supply of farmyard manure, or its equivalent, is available for application to the soil, not only will the inherent cropping power of the seed produced be reduced, so that future crops will deteriorate, but the food produced will be lacking in vitamins essential to the health and development of the people.

The importance of vitamins in the national diet and as a factor in national health, especially of children, needs no emphasis. The subject is a popular one as witness the fact that it was chosen for the B.B.C. National Lecture on 22nd January, 1932, by Sir F. G. Hopkins, D.Sc., the President of the Royal Society. In this lecture he pointed out the importance of the relation of the sufficiency of vitamins in our daily food to resistance to infectious and bacterial diseases, quite apart from the question of total lack of any one vitamin, in which case a definite deficiency disease would make its appearance.

The absolute necessity for an organic basis for any successful manurial system having been established it becomes imperative to examine all possible sources of such manure. Farmyard manure is difficult to obtain in sufficiently large quantities. With the disappearance of the horse and the increase in mechanical traction in Europe, and the mechanisation of farming operations everywhere, the scarcity of farmyard manure becomes yearly more acute, especially for the small holder.

Other sources of supply must, therefore, be found, and one which at present very largely runs to waste is town sewage and town refuse. Were this converted into good manure it would be an inexhaustible and constant supply at hand for the benefit of agriculture.

In the eyes of the biochemist the great towns are parasitic upon the country surrounding them. Tons and tons of food are poured into them day and night from the country and nothing is returned. The food is consumed and the residue, in the form of sewage and refuse, becomes a costly nuisance of which it is difficult to dispose. The biochemist sees nitrogen being taken from the land and poured into the cities, and he would like to see the waggons which bring this in as food going back laden with nitrogen again in the form of fertiliser. If a method could be found of converting this waste back into fertiliser this vision would materialise. Such a method exists.

Activated Sludge Process.

In the design of plants for sewage disposal there has been a tendency in recent years for engineers to break away from the anaerobic, or septic tank, treatment in favour of aerobic methods. The most satisfactory of these latter methods is, in all probability, the Activated Sludge Process.

For the efficient oxidation of sewage two essentials are necessary, viz. :—air and a suitable bacterial culture developed under aerobic conditions, and the more intimate the contact between these and the sewage, the more rapidly will oxidation take place and the more efficient will be the system.

In the Activated Sludge Process, the main action takes place in specially designed aerating tanks. In some cases air is supplied from the bottom of the tanks by means of diffusers, made from special porous material, as well as by absorption at the surface. In other cases air is supplied by means of surface aeration only. This is intensified by the use of mechanical devices which break the surface and accelerate the rate of absorption of air.

In the early days of the process, at the suggestion of Dr. Gilbert Fowler, "activated sludge" was built up in the following way. The tank was filled with sewage and aeration continued until all the ammonia had been oxidised and converted into nitrites and nitrates. Aeration was then stopped and the solid material in suspension rapidly sank to the bottom, leaving a clear liquid which could be decanted. This small quantity of settled matter was "activated sludge", consisting of a mixed bacterial culture which under aerobic conditions had the power of flocculating and oxidising sewage very rapidly. When this sludge was left *in situ* and the tank again filled up with sewage and aeration continued, the oxidation of the second filling took place more rapidly owing to the presence of this bacterial culture. As the process was repeated, oxidation of each filling took place more and more rapidly until, when the tanks contained about 25 per cent. of "activated sludge" after one hour's settlement, complete nitrification took place in a few hours. This method of purification is known as the "fill and draw" method of treatment, but it has since been found more convenient to operate continuously, and the sludge is now settled out in a separate tank.

In both cases excess sludge is withdrawn and can be used as a fertiliser.

About 42 tons of wet sludge are obtained from a million gallons of sewage. The sludge is dark brown in colour with an earthy odour and contains a very large number of bacteria. The dry sludge has a high nitrogen content and its value as a fertiliser is very great. The organic matter varies from 64.7 to 70.4 per cent., the nitrogen from 3.75 to 7.08 per cent., and the phosphate from 2.1 to 4.2 per cent. Many experiments have been conducted, both at Rothamsted and in other countries, to determine the manurial effects of this

sludge and the results have been highly satisfactory. Moreover, feeding tests have shown that it is a valuable source of vitamin supply to crops.

The crude sludge, however, contains 97 to 99 per cent. of water, and herein a great difficulty occurs in its use as a fertiliser. It has been found difficult in the past to devise means of drying it to a spadable consistency fit for commercial use. In tropical countries like India no difficulty is found in sun-drying the sludge and it can be easily utilised, but air-drying in moist climates is not feasible. At Milwaukee on Lake Michigan, where very large works are installed, the sludge is got into a marketable form by a combination of chemical treatment, filtration, and finally, artificial drying, and it then finds a ready sale among farmers. Such methods are admittedly expensive and troublesome though profitable. If any more satisfactory method can be devised of getting the sludge into a spadable and easily transportable condition, we have here a most valuable source of organic manure.

The Activated Sludge Process has two aspects. It may be looked upon as a satisfactory and economic method of *sewage disposal*. That this aspect is fully recognised is evident from the fact that many of the large cities of the world are now adopting, or have already adopted this system; London, Manchester, Birmingham, Toronto, New York, Chicago, Berlin, Oslo, Helsingfors, can be instanced in this respect.

Sewage Utilisation.

There is another aspect to be considered which is even more important, and that is the agricultural aspect. From this point of view the Activated Sludge Process of sewage disposal may be looked upon as a *fertiliser factory*, a method of redeeming the waste products of civilisation and returning them to the land, and removing the parasitic nature of towns to which reference has been made. Here would seem to be the realisation of the dream of the biochemist, a dream no longer, but a practical process. The town sewage consisting mainly of the waste products of food grown in the surrounding countryside is rapidly converted into nitrogenous organic fertiliser which is returned to the land to be once more converted into food for the town. Waste is prevented, the nitrogen cycle is closed, and the leakage is small.

Sewage disposal is not everything. The products of disposal should be *utilised* and until this is more fully recognised, biological processes of handling sewage and town refuse, such as the Activated Sludge Process, will not attain the popularity which they merit. The sludge obtained in these processes is one of the best plant foods which can be obtained. This fact is better recognised in America than in England. There the fertiliser manufacturers are willing to use all they can get and pay a fair price for it. In England, the farmer would learn to utilise this form of fertiliser were it made attractive and got into such a form that it could be easily handled.

In their original patent of the Adco process of converting waste products, like garden refuse, leaves, weeds, straw, &c., into "farmyard manure", Richards and Hutchinson claim to activate the carbonaceous material therein by maintaining it in contact with a solution of soluble nitrogen for a certain period of time. The process has been very widely developed and a large variety of waste products has been successfully utilised for the purpose. In the tropics the best activator to use appears to be cow dung or urine, but activated sludge itself, containing as it does all the organisms naturally present in good arable soil, offers a still better starter, or activator. In experiments carried out at the Indian Institute of Science at Bangalore in South India, piles of refuse and fallen leaves moistened with sullage were activated with sludge and broke down with increasing rapidity.

Town Refuse.

The success of these experiments suggested others using town refuse as the basic material, and a series of such experiments conducted at Cawnpore and elsewhere by Dr. Gilbert Fowler and other workers has proved that such material can be converted with comparative ease into valuable manure.

The liquid activated sludge is run on to heaps of refuse and these turned over from time to time. A rapid rotting down of the refuse takes place resulting in the production of a fine humus, which is of considerable value as a fertiliser, and which may be "fortified" as may be required with ingredients, such as phosphates, suitable for special crops.

It is suggested that this process might be adapted to convert town refuse, the disposal of which is at the present time a source of embarrassment to municipalities, into useful manure. At the same time the problem of converting activated sludge into a transportable form would be solved. If the refuse freed from tins and bottles, and such inert material, was systematically mixed with activated sludge from the sewage works and allowed to ferment it would absorb much of the superfluous moisture and result in a valuable organic manure with very much the same composition as farmyard manure, and in a transportable form. Two problems would have been solved. The sludge would be dried and the town refuse disposed of and made available for agriculture. This refuse which is now apt to be a costly nuisance could be converted into a fertiliser for which the need is greatly felt, especially in the neighbourhood of towns.

Activated Composts.

In addition to sewage and town refuse there are many other waste products which can be converted into manure. On many farms large quantities of weeds, roughage from ditches and roadsides, crop residues like maize stalks, &c., are available. Whatever the waste material used the general

principle underlying their conversion into compost remains the same, and their correct use in the soil involves two distinct processes: (*a*) the fermentation of the organic matter to produce humus, and (*b*) the slow oxidation of humus to produce nitrogen available to the crop.

The requirements of the first stage are so intense that if it is allowed to take place in the soil itself it is apt to interfere with the development of the crop. The fungi and bacteria which break down the vegetable and animal residues require the same food as the crop, and thus compete with it by removing nitrogen from the soil solution. This is why the benefit of burying a green dressing is often delayed for a considerable period.

The needs of the second stage are less intense and can proceed in the soil without harm to the crop.

These two stages should be separated and the first, the preparation of humus, conducted outside the soil. The resulting humus is then incorporated with the soil and the growing crop can take immediate advantage of it. This principle was grasped by the Chinese long ago, and it is now becoming more and more recognised in Europe.

The best results are obtained when the ratio of carbohydrates to nitrogen is about 30 : 1 in the waste material used. In the presence of suitable micro-organisms and under aerobic conditions, fermentation is rapid with a steep rise in temperature of 50° to 70°C. Large quantities of carbon dioxide are evolved and the readily decomposable constituents of the waste material are broken down. The fermentation then slows down, the temperature falls, and the resulting product resembles soil humus with a carbon nitrogen ratio of approximately 10 : 1.

At this stage the heaps should be broken down and fresh waste material added with thorough turning and mixing, when the process begins over again. It is in fact analogous to keeping a fire burning.

Method of Preparation.

In actual practice a systematic and continuous process of manufacture of these activated composts, as they are called, can be devised. Such a process may be briefly outlined as follows.

The waste material is made into a heap three feet wide at the base, two feet high, and six feet long, big material being chopped into pieces about two inches long. This heap is thoroughly mixed and moistened with an "activator", which may be cow dung and urine, or night soil emulsion, or sewage sludge, or in the absence of all these, Adco, or a solution of sulphate of ammonia. Rapid fermentation and rise in temperature will result and after a week or so the latter will fall and the fermented material now itself constitutes the "starter" or "activator" for further heaps. A quarter of the heap is now removed to form the basis of a second heap, and the first heap is made up to its original size with fresh waste material and well mixed again, more activator solution being added. Fermentation will again take place with a rise in temperature. As this falls a quarter is again removed and added to the second heap. This procedure is repeated until the second heap is the same size as the first. The next operation is to form a third heap in the same way removing a quarter of the second heap as a basis, and at each operation transferring a quarter from heap to heap, fresh material being added to the first heap only.

The process can now be made a continuous one, fresh material being constantly added to the first heap and the finished product removed for use from the third heap. Should the waste material used prove very refractory, a series of four heaps may be necessary, but three is usually sufficient.

In course of time it will probably be found that the fermentation becomes more rapid owing to the development of large numbers of the micro-organisms specially suited to the local conditions, and it may then be possible to take away half of each heap at a time and thus speed up the process.

The time required to get the three heap system going will vary with the character of the waste material used, the activator, and the local conditions of climate, &c., but it should not exceed three months, and after this compost can usually be withdrawn for use every three weeks or so.

Moisture is an important factor and in very dry climates water may possibly have to be added to the heaps before the process is complete. When this is necessary it is a good plan to use the activator solution for the purpose if it is available in quantity. No hard and fast rules can be laid down, however, and the exact technique suitable to the local conditions must be discovered by experiment.

The area and volume of the heaps required will depend upon the quantity of the refuse to be dealt with. If larger heaps are required they may be lengthened, but they should not be materially increased in height or width. Packing of the material must be avoided and conditions kept aerobic or the wrong kind of fermentation will take place, with the development of bad smells and loss of nitrogen. For this reason heaps are superior to pits, as the latter usually become anaerobic and give trouble. In the majority of cases where difficulties have occurred with the process they have been due to packing of the heaps and the onset of an anaerobic fermentation.

Value of Activated Composts.

The actual composition of activated composts produced in the way suggested naturally varies to some extent with the nature of the waste material used, but the nitrogen content is usually in the neighbourhood of one per cent. and they are comparable with good farmyard manure.

Activated composts have one great advantage in their favour as compared with farmyard manure, they contain few viable seeds. During their preparation the fermentation set up causes a temperature sufficiently high to kill seeds and most insect larvae, like fly maggots. Their use, therefore, tends towards clean cultivation and a

saving of labour. Where they have been used in India it has been especially remarked that very little had to be spent on weeding.

As regards the actual value of activated composts in the field, trials made in India have given good results. At Mysore City, 7,000 tons of compost have been made from the city refuse using night soil as activator. This can be sold at the site for Rs. 2, as. 13 per ton (about 4s.). A great deal of it has been used by the Agricultural Department for manuring sugar-cane with marked increase of crop.

The compost has, however, never been properly tested out in the field and there is need for a well designed experiment on a permanent manurial plot plan to test the merits of activated composts as compared with farmyard manure and minerals over a period which will show their effects reflected in successive crop yields.

Meanwhile it is claimed that the process adumbrated above affords an easy and cheap method of producing large quantities of valuable organic fertiliser and potential agricultural wealth from a variety of products which now go to waste.

CACAO IN FERNANDO PO.

[*Abstracted from a paper by Leonard J. Schwarz appearing in the January number, 1934, of the "Officiel Bulletin of the Office International des Fabricants de Chocolat et de Cacao."*]

Fernando Po is a small volcanic island consisting mainly of mountain peaks situated off the coast of West Africa. Cacao cultivation is confined to the coastal zone not more than six miles wide and never exceeding 1,600 feet in altitude. The climate of these areas is characterised by high relative humidity, abundant rainfall (67 to 162 inches) and warm but fairly even temperatures (78.3°F. to 80.1°F.). The 'dry season' is merely a period when less rain falls than usual. It occurs generally from December to February and a further dry period may occur in July or August. The soil is fertile to depths ranging from 15 to 60 feet and on some farms yields are very heavy. Generally the soils are rich in humus and poor in calcium.

The total area under Cacao is 61,750 acres of which 17,290 acres have not yet come into bearing. There are farms run by Europeans, chiefly Spanish, and in addition, there are native holdings. The types grown are Amelonado (90 per cent.) and Calabacillo (8 to 9 per cent.). There is a small acreage under Criollo which has been grafted on to Forastero stocks. This will shortly come into bearing and the progressive venture is rapidly climbing out of the experimental stage.

Yields vary considerably. In the Sampaka district 2,678 lb. per acre have been reported and there are individual trees which are known to bear 400 pods per annum. The mean output from peasant plantings is about 223 lb. per acre and from farms 650 lb. per acre.

The peasants plant and cultivate very crudely. On the farms better methods are adopted. Seeds are selected and planted in nurseries while the orchards are being prepared. Spacing varies from 9 to 11 feet. The estimated cost of clearing and planting one acre is $32.00. The orchards are kept clean and lightly pruned.

Although in places lanes of trees have been planted as windbreaks little attention is paid either to this or to shade trees. Belief is firm that with proper spacing the trees themselves shade the soil sufficiently and need no further overhead shade. In some places Albizzias and Erythrinas have been planted but they are not considered helpful. Little thought or effort is expended on cover crops or manuring. With tsetse fly there are few cattle for pen manure and no cheap and suitable fertilizers are to be had on the island. Some artificials have been imported and tried with indifferent success. The fields are brushed regularly and the débris left as mulch.

Pests are common. The most destructive are *Phytophthora faberi* (Black Pod), *Helopeltis*, thrips, collar crack and root rot. Some orchards are sprayed twice or even four times a year. The most effective spray has been found to be an aqueous mixture of two per cent. copper sulphate, $1\frac{1}{2}$ per cent. lime, and two parts per 1,000 of nicotine sulphate of 40 per cent. strength. Small black ants are encouraged as they are thought to destroy thrips.

The harvest season commences in June or July and lasts till the end of the year. Most planters have no great interest in fermentaries and the more progressive only ferment for 36 to 48 hours. Consequently the beans are never properly cured. Drying has often to be aided by artificial means.

Transport to the coast is by road and water. Overland hauling is restricted because there are only 37 miles of public roads. Most of the crop is exported to Spain. Schemes for grading the beans for purity after the fashion adopted in West Africa are under consideration.

F. J. P.

FERTILISERS.

Fertilisers help plants to form more foodstuffs, but they do it by increasing the total area of the leaf surface and not by raising the efficiency of the individual leaf as a synthesizing unit. This conclusion was reached by E. Basyrina and V. Tchesnokov, of the plant physiological section of the Russian Academy of Sciences, as a result of their experiments with oats grown in culture solutions. Given varying rations of phosphorus, nitrogen and potassium, the plants responded by varying their leaf areas, but unless the leaves became deficient in chlorophyll, the amount of food formed by a given unit area did not change. (*Science*, Vol. 78, No. 2031, 1933. supp. p. 10.)

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Java Clarification Practice.—*C. Sylmans.*

It is of interest to note the number of defecation factories in Java applying cold, warm and hot liming, there being for example, out of a total of 75 factories, 23 adding the lime to the raw juice at a temperature below 50°C.; 23 at 50 to 90°C.; 21 above 90°C.; while there are 3 which pre-lime in the cold and finish hot.

There are a number of special methods of liming in use such as: Lime saccharate may be added to the hot raw juice containing about 25 per cent. of settlings from a previous operation; the cold raw juice may be run into about ¼ of the raw juice containing all the milk-of-lime; cold raw juice may be limed to 7.5 to 8.5 pH, heated to 100°C., sulphited continuously, and finally treated with lime saccharate; cold raw juice may be pre-limed with filtered juice at 9.8 pH, and afterwards limed at 80°C., cold raw juice may be pre-limed to 6.9 and after-limed to 7.4 pH; cold raw juice may be pre-limed with strongly alkaline filtered juice; pre-liming the cold raw juice with filtered juice at 10 pH, heating to 100°C.; and lastly liming with milk to the required pH; pre-liming the cold raw juice and after-liming after heating; and adding most of the milk-of-lime to the cold raw juice, and the rest in the settling tanks; often the mixing of juice and milk-of-lime is effected by compressed air.

Regarding the first mentioned method in which about 25 per cent. of the settlings from a previous defecation is added to the raw juice before liming, this is stated to give a better settling, a better filtration, and a lighter coloured juice. No comments are made on the results given by the other methods.

In regard to liming in sulphitation factories, in five of them the milk-of-lime is added by means of compressed air to the juice in the sulphitation tanks. At two factories, the addition of the lime is done by *van der Jagt's* method. At another factory, Kentjong, the cold raw juice is first pre-limed with two litres of milk-of-lime at 15° Bé. per 1,000 litres. At Redjoagoeng, carbonatation is being continuously operated.

In the following table, the average amounts of lime used in the three types of factories is given, A denoting the number of litres of 15° Bé. milk-of-lime per 1,000 litres of raw juice, and B the lime per 1,000 of cane.

	Defecation.		Sulphitation.		Carbonatation.	
	A.	B.	A.	B.	A.	B.
1930 ..	3.2	0.80	11.7	1.70	104.5	31.8
1931	4.2	0.79	11.3	1.65	102.2	31.3
1932	4.3	0.75	10.8	1.51	101.2	30.6

Figures are also given for the lime content of the clarified juice expressed in mgrms. CaO per 1, this averaging in 1932 for defecation, sulphitation and carbonatation, 449, 540 and 223. During the past 5 years this figure has remained about the same for defecation factories; that for sulphitation has decreased somewhat; but there is shown a marked decrease in the case of the carbonatation houses, being now about half of what it was then.

Some average filtration figures for the three types of factories for the year 1932 may be added: Pol. in filter mud per cent. pol. in raw juice 0.73, 0.82, 0.48: dry substance in the filter mud per cent. cane, 0.68, 0.84, 3.41; quotient of purity of the filter mud, 12.9, 11.8, 1.8; kg. of dry substance of the filter mud per sq. m. of filtering surface per 24 hours, 22, 26, 124.—(*Inter. Sugar Journ.*, Vol. XXXV, No. 420, p. 479.)

* * *

Preventing Crystallization of Table Syrups.—*W. E. Cross.*

Referring to results recently published by Lohr, according to which crystallization of sucrose from sugar-cane table syrups may be prevented by adding a commercial preparation of invertase to the finished product, the author calls attention to a "natural" method of accomplishing the same result, particularly as regards some of the POJ canes.

This is to cut the cane and leave it lying for a time in the field. Invertase immediately begins to form in the cut cane and, if the weather is warm and dry, five or six days will be sufficient to bring about the formation of enough invert sugar to keep the remaining sucrose in solution.

This method is especially applicable to POJ 36 213 and 234, and also to the Zwinga variety. On the other hand, the Purple and Striped canes and POJ 228 contain very little invertase, even many days after cutting. If the cane is left too long after cutting, the taste of the molasses may be affected.—(*Inter. Sugar Journ.*, Vol. XXXV, No. 420, p. 486.)

* * *

Deterioration in Cut Cane.—*A. S. Alvarez.*

Cane cut and topped deteriorates more slowly than when left with the tops on. It has been supposed that the reason for this difference lies in the existence of certain enzymes in the growing point of the cane which diffuse into the stalk and bring about the formation of invert sugar.

Experiments carried out with POJ 36 and POJ 213 in Tucuman show the rates of deterioration of topped and untopped cane of these varieties is the same. Hence it appears that in these canes the theory of the migration of invertase from the top to the stalk is inadequate to account for the facts.—(*Inter. Sugar Journ.*, Vol. XXXV, No. 420, p. 486.)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

The Soviet Chemical Industry.

The Five-Year Plan has necessarily included a chemical industry, the growth of which is stated to have been one of the outstanding achievements of the plan. It is said to have involved an expenditure of 1,500 million roubles devoted to the production of sulphuric acid, nitrogen, mineral salts, superphosphate, synthetic rubber, artificial fibre, drugs, aniline and lacquer dyes. The production of sulphuric acid has grown from a pre-war figure of 150,000 tons to 800,000 tons.

Chiefly, in view of the difficulty of getting foreign exchange, Russia like many other countries, has embarked on a policy of manufacturing everything for herself. A country of such vast area must have enormous untapped and even undiscovered resources in the shape of natural products, which the chemist and the chemical engineer can exploit, and it must be expected that given the necessary supply of skilled chemists Russia will continue to expand industries which are based on these.

Vast quantities of apatite have been discovered and deposits of phosphate in reserve are estimated at 1,200 million tons, a thirty-fold increase in five years. This is a most important find in view of the world of phosphatic manures. Another mineral peculiar to Russia, of which large deposits have been found, is nepheline—a sodium, potassium, aluminium silicate of considerable industrial importance. Anthracene is another chemical of which the Russian production is expanding; the output last year was expected to reach 1,500 tons and to expand five-fold within the next three or four years. The value of chemicals imported into Russia has meanwhile fallen materially amounting last year to only one-sixth of what it was in 1930, and it is quite clear that chemically Russia is changing from an importing to an exporting nation.—(*Chemistry & Industry*, 1933, Vol. LII, No. 45, p. 904.)

* * *

Decomposition of Greenheart under Industrial Conditions.

Examinations of a greenheart pile embedded for forty years at Cardiff in a bank consisting of rubble, ships' ballast, clinker and ashes resting on a bed of river mud, showed that the pile had undergone limited external decomposition. The pile was about 20 feet long and 18 inches square, and decomposition had occurred to a maximum depth of 3.5 inches, being greatest in the middle of the pile and least at the ends; there was little sign of ground-line erosion. There was a sharp line of demarcation between the decayed and sound woods, but this line did not represent the difference between heartwood and sapwood. The decay of the wood was accompanied by the infiltration of calcium and aluminum compounds and the formation of much acidity. The acid was not identified, but was probably a product of the decomposition of the woody tissue. The process of decay was not a gradual one, the timber retaining its mechanical strength and chemical composition until such time as decay occurred. (*J. Soc. Chem. Ind.*, 1933, Vol. LII, *Trans. p.* 283. *Analyst* 1933, Vol. LVIII, No. 693, p. 772.)

* * *

Soy Bean as a Source of Food and Milk for Diabetics.

The Austrian botanist, Friedrich Haberlandt, was the first to recognize the importance of the soy bean as a splendid source of food, and he pointed out the possibility of cultivating this plant in middle Europe. The process worked out by L. Berczeller in Vienna, for purifying the soy bean, which is known to be especially rich in protein and fat, has made possible the production of soy bean meal that still shows the total fat and lecithin content of the bean and yet does not become rancid. Later, E. Kupelweiser in Vienna utilized and perfected this process on a technical scale. Of the many uses of edible soy meal, which has been produced on an industrial scale in Austria for five years, its application as a food for diabetics has recently been placed on a new basis. It was known that no starch is found in the 20 to 22 per cent. of carbohydrates in the purified soy meal. Later analyses have shown that an average of only five to six per cent. of sugar-forming substances (calculated as sucrose) is present in purified soy beans. The rest of the carbohydrates, consisting of stachyose, 5.66 per cent., araban, 4.83 per cent., and galactan, 6.18 per cent., is harmless to diabetics. By the addition of the necessary technical baking supplements to edible soy meal, a bread has been successfully produced which, on the basis of C. Noorden's investigations dealing with its value in metabolism experiments, shows only one-fourth as much sugar-forming substance as normal bread. In taste and appearance this bread comes so near to ordinary whole-grain bread that it can scarcely be distinguished from it. Moreover, there is the practical advantage that this new bread, now being manufactured for diabetics on a factory scale, is markedly cheaper than most of the baked products hitherto used by diabetics.

The old problem of the production of soy milk has also been worked out recently in Austria. By suitable preliminary treatment of soy beans, M. Adler has been able to produce a soy milk which is completely neutral to the taste and can scarcely be distinguished from cow's milk. Moreover, in chemical composition and physical properties it appears to be quite equal to animal milk. On account of its low cost this product could assume importance in the food-processing industries. The process is also probably suitable for the production of milk for diabetics and the manufacture of diabetic milk preparations which must meet special requirements regarding protein content, &c.—(*Ind. & Engin. Chem. News Ed.*, Vol. XI, No. 23, 1933, p. 347.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR:—Prices on the Home Market have ranged as follows (c.i.f. per cwt.):—

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
28th December	4	5¼	9	3
4th January	4	6¾	9	6
11th January	4	7½	9	6¾
18th January	4	7½	9	7½
25th January	4	7½	9	9
1st February	5	2¼	10	0
8th February	5	6¾	10	3¾
(*9th Feb.*, 1933)	5	1½	9	10½

After a somewhat inactive market raws have more recently tended to harden with values generally showing some improvement. Further perplexities have been introduced in the World situation by the new American policy which provides for the revaluation of the dollar at between 50 per cent. to 60 per cent. of its par value in gold and the nationalization of all gold in the U.S.A. Under its stimulus there has been an all round advance in commodity prices in America but this has not been generally maintained. As some time must elapse before the full significance of the operation of this policy can be grasped, markets as a whole have assumed a hesitant tone. The future of the article will also depend on the extent of Cuba's output this year which it is difficult at present to estimate.

* * *

COCOA.—There has been a better feeling in the cocoa market and the general improvement in economic conditions has made speculators very nervous with the result that prices have improved considerably. Latest quotations were as follows—Good Fermented Accra 21*s.* 6*d.*, Fine Cameroon 22*s.* to 23*s.* and in Trinidad $7.50 a fanega is being paid.—(*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

COFFEE.—Prices have generally been firmer, latest quotations including Costa Rica, new crop from 86*s.* to 121*s.* per cwt; bold colony Kenya up to 130*s.*, superior Santos at 45*s.* Twenty-two barrels of pale greenish Jamaica were offered and sold recently at 75*s.*

* * *

BANANAS.—The market is quiet for all kinds and prices continue at the low level established a fortnight ago, *i.e.*, Jamaicas £15 5*s.* per ton delivered London and £15 nearest station Provinces, and Brazilians £17 nearest station. —(*West India Committee Circular*, 18th January, 1934.)

RUBBER.—Quotations for Plantation Sheet have ranged as follows:—

	d.
27th December	4 3-16
3rd January	4 19-32
10th January	4 3-4
17th January	4 1-4
24th January	4 5-8
31st January	4 3-4
7th February	4 15-16
(*8th Feb.*, 1933)	2 3-32

In the absence of definite news concerning the outcome of 'restriction' negotiations the rubber market has been somewhat inactive. American rubber consumption for December last is stated to be 29,087 tons and estimated at 415,000 tons for 1933 which is the highest since the record of about 500,000 tons in 1929.

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association:—

	American Mid.	*Egyptian F.G.F. Sakel.*
29th December	5.33	7.74
5th January	5.64	8.28
12th January	5.88	8.53
19th January	6.05	8.40
26th January	6.07	—
2nd February	6.23	—
9th February	6.60	—
(*10th Feb.*, 1933)	5.09	7.29

Prices of American-mid since the beginning of the New Year have advanced as a result of political developments in the U.S.A., the advance of Egyptian, fair general buying and a shortage of contracts. Stocks of unsold cotton are stated to be much smaller than last season. The strength of Sakel is due to small supply and the deficient quality of this growth. A small business has been done in West Indian Sea Island, sales including 30 bales at from 14*d.* to 16*d.*

* * *

COPRA.—Remains quiet and West Indian is 7s. 6d. per ton lower at £9 10s. c.i.f. London.—(*West India Committee Circular*, 18th January, 1934.)

* * *

GRAPEFRUIT.—The average prices ruling in Covent Garden for the week ending January 13th were:

	s.	*d.*		*s.*	*d.*
Jamaica	8	0	to	11	0
British Honduras ..	12	0	,,	15	0
Palestine	11	0	,,	14	0
Florida	11	0	,,	12	0
Puerto Rico ..	10	0	,,	12	0

—(*West India Committee Circular*, 18th January, 1934.)